A Meta-Methodology for the Design and Modeling of Patient Journeys

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A dissertation submitted in fulfillment of the requirements for the degree of Doctor of Philosophy.

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Dedication

I would like to thank my family and close friends for their support and patience over the last 5 years. They have at times had to deal with someone who was completely consumed with this thesis and they were always there with an encouraging word or a hug.

Special thanks needs to go to my wonderful sons, Nicholas and Daniel, who over the last year started many sentences with “When you finish your thesis, can we…?” There will now be plenty of time to do all the things we put on hold. I adore you for the amazing people you are becoming and the incredible understanding that this was something I needed to do not only for me but for the long term future of our family as well.

I also received great support from Allan, who in the darkest most doubtful days kept telling me that ‘I had come too far to let it go now’. Your caring is always appreciated.

My grandparents also deserve special mention for their quiet encouragement. Their pride in what I was doing was worn proudly on their sleeve for all to see and they can’t wait till my graduation. Of particular note is my grandmother Daphne, who moved in for a number of months to help mind children, clean house and cook meals. What a great help!

And finally to my two dogs, Sascha and Bella, who sat with me for many hours, just resting their head on my knee or foot. They were always ready with a wagging tail that never failed to bring a smile to my face. Animal therapy should never be underestimated!
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The staff and management at Ryde Hospital Maternity Department provided a great case study environment and the midwives involved contributed to the patient journey modeling sessions with fantastic vigour and passion. The results have been beneficial for us all.

And last but not least I would like to thank my research supervisors: Associate Professor Carolyn McGregor and Professor Sally Tracy. Their ongoing commitment to expanding my research mindset and writing style was fantastic. There were times when the enormity of the project almost overcame me but Associate Professor McGregor in particular was always there with an encouraging word and healthy push to keep moving forward. Our relationship has many dimensions, including teacher, mentor and friend and for this I will be eternally grateful. I know our research collaborations will also continue for a long time to come. Thankyou Carolyn and Sally, for everything.
Statement of Authentication

The work presented in this thesis is, to the best of my knowledge and belief, original except as acknowledged in the text. I hereby declare that I have not submitted this material, either in full or in part, for a degree at this or any other institution.

..........................................................
(Signature of Candidate)
Publications Related to Dissertation


- **Curry, J.M.,** (2005), *Deficiencies Of Process Reengineering In Its Support For Healthcare Redesign*, University of Western Sydney, CSTE Innovation Conference, 8-9 June 2005, Penrith, Australia, pp.19-20. *(Awarded Joint Best Paper)*
Research Grants Related to Dissertation

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Grant Value: $528,000- (AUD)

Project Title: “1 + 1 = A Healthy Start to Life”

Partner Organisation: Charles Darwin University, Northern Territory, Australia.

My Role: Chief Investigator

The research project is a 5 year, 3 stage, baseline, intervention and post-intervention study which is designed to improve maternal and infant health for remote dwelling Aboriginal families in the Top End of the NT. It is based around initial scoping work with women from our field sites Maningrida and Wadeye, health workers and policy makers who confirmed the feasibility and importance of the study. The project will use the Patient Journey Modeling Meta-Methodology (PJM³) and the PaJMa Patient Journey Modeling tool, developed as part of this thesis, along with participatory action research to research and introduce change simultaneously. Consultation has suggested and evidence confirms that health service re-design, our intervention, will be based on ‘women centred’ continuity of care, and proactive, intensive and focused support for mothers, infants and families. Further consultation, baseline data and evidence will be used to design the specifics of service improvement. This will be evaluated post-intervention against baseline data from our two field sites and aggregated data already routinely collected from across the NT. Data collected will include organisational data for example costing and workforce utilisation, outcomes data such as measures of health and wellbeing in women and infants and the experiences of women, their families and practitioners with the health system pre and post intervention generated using ethnographic methods.
Human Ethics Clearance

Human Ethics approval for the project entitled “A patient journey model through primary care in a midwifery group practice” was received from the Northern Sydney Central Coast Area Health Service Human Research Ethics Committee on the 16th August 2006.

The Protocol No. is 0608-128M.

The University of Western Sydney Human Research Ethic Committee recognised this external approval on the 15th March 2007. The UWS Registration Number is HREC 07/034.
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<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ACHS:</td>
<td>Australian Council on Healthcare Standards</td>
</tr>
<tr>
<td>ACSQHC:</td>
<td>Australian Commission on Safety and Quality in Health Care</td>
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<tr>
<td>BPD:</td>
<td>Business Process Diagram</td>
</tr>
<tr>
<td>BPEL4WS:</td>
<td>Business Process Execution Language for Web Services</td>
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<td>BPMN:</td>
<td>Business Process Modeling Notation</td>
</tr>
<tr>
<td>BPR:</td>
<td>Business Process Re-engineering</td>
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<tr>
<td>BSC:</td>
<td>Balanced Scorecards</td>
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<tr>
<td>CDSS:</td>
<td>Clinical Decision Support System</td>
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<tr>
<td>CIG:</td>
<td>Computer Interpretable Guidelines</td>
</tr>
<tr>
<td>CPI:</td>
<td>Clinical Practice Improvement</td>
</tr>
<tr>
<td>CPJM:</td>
<td>Current Patient Journey Model</td>
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<tr>
<td>CPOE:</td>
<td>Computerised Physician Order Entry</td>
</tr>
<tr>
<td>DRG:</td>
<td>Diagnosis Related Group</td>
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<tr>
<td>EBM:</td>
<td>Evidence Based Medicine</td>
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<tr>
<td>EHR:</td>
<td>Electronic Health Record</td>
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<tr>
<td>FPJM:</td>
<td>Future Patient Journey Model</td>
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<td>HCl:</td>
<td>Health Care Improvement</td>
</tr>
<tr>
<td>HCO:</td>
<td>Health Care Organisation</td>
</tr>
<tr>
<td>HL7RIM:</td>
<td>Health Level 7 Reference Information Model</td>
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<tr>
<td>IHI:</td>
<td>Institute of Healthcare Improvement</td>
</tr>
<tr>
<td>IOM:</td>
<td>Institute of Medicine</td>
</tr>
<tr>
<td>ISO:</td>
<td>International Standards Organisation</td>
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<tr>
<td>IW-MONS:</td>
<td>Intelligent Workflow Monitoring System</td>
</tr>
<tr>
<td>JAD:</td>
<td>Joint Application Development</td>
</tr>
<tr>
<td>JCAHO:</td>
<td>Joint Commission on Accreditation of Healthcare Organisations</td>
</tr>
<tr>
<td>MDDDB:</td>
<td>Multi-dimensional Data Base</td>
</tr>
<tr>
<td>MDSS:</td>
<td>Management Decision Support System</td>
</tr>
<tr>
<td>MFI:</td>
<td>Model for Improvement</td>
</tr>
<tr>
<td>MIS:</td>
<td>Management Information System</td>
</tr>
<tr>
<td>NHS:</td>
<td>National Health Service</td>
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<tr>
<td>OLAP:</td>
<td>Online Analytical Processing</td>
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<tr>
<td>PaJMa:</td>
<td>New Patient Journey Modeling tool</td>
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<td>PAS:</td>
<td>Patient Administration System</td>
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<td>PDSA:</td>
<td>Plan-Do-Study-Act</td>
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<tr>
<td>PJM:</td>
<td>Patient Journey Model</td>
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<tr>
<td>PJM²:</td>
<td>Multi-dimensional Patient Journey Model Conceptual Design</td>
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<td>PJM³:</td>
<td>Patient Journey Modeling Meta-Methodology</td>
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<tr>
<td>PMAF4HC:</td>
<td>Process Modeling Assessment Framework for Healthcare</td>
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<tr>
<td>RMGP:</td>
<td>Ryde Midwifery Group Practice</td>
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<tr>
<td>SIPOC:</td>
<td>Supplier-Input-Process-Output-Customers</td>
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<td>TQM:</td>
<td>Total Quality Management</td>
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<tr>
<td>UML:</td>
<td>Unified Modeling Language</td>
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<tr>
<td>VSM:</td>
<td>Value Stream Mapping</td>
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<td>WiMC:</td>
<td>Workflow Management Coalition</td>
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<tr>
<td>XML:</td>
<td>eXtensible Markup Language</td>
</tr>
<tr>
<td>XPDL:</td>
<td>XML Process Definition Language</td>
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<tr>
<td>XSL:</td>
<td>XML Stylesheet Language</td>
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ABSTRACT

The 1999 United States Institute of Medicine (IOM) report ‘To err is human: Building a safer health system’ resulted in huge public attention on the crisis in the US health care system and the apparent lack of patient safety. The IOM’s subsequent report, ‘Crossing the quality chasm: A new health system for the 21st century’ was released in 2001 and outlined six (6) overarching ‘Aims for Improvement’. It stated healthcare must be redesigned to be: Safe; Effective; Patient-Centered; Timely; Efficient and Equitable.

These six aims have formed the basis for change programs not only in the US but healthcare delivery systems worldwide. This is demonstrated by the number of countries that have nominated healthcare improvement (HCI) as a priority issue and the allocation of substantial federal budgets for quality improvement initiatives in countries such as Australia, the United Kingdom, Canada and the United States.

The focus on patient safety and the delivery of improved health care has seen many organisations initiating improvement projects aimed at redesigning the delivery of healthcare and in particular, the patient’s journey. Patient Journey Modeling is a patient-centric activity that details a patient’s progress through a healthcare system for a given service. The goal of Patient Journey Modeling (PJM) is to improve health care quality by eliminating unproductive work and reducing variability within the care process.

The original contributions of this thesis enhance the field of healthcare improvement by providing new constructs for the conduct of patient journey modeling projects. More importantly the major contributions of this research provide practical tools that can be used by healthcare staff with little or no previous process improvement experience to improve the consistency and quality of outcomes for patient journey redesign initiatives. Significant research contributions are made in five areas:

1. Provision of a domain specific improvement architecture;
2. An assessment framework for process modelling tools;
3. A Multi-dimensional Patient Journey Modeling Conceptual Design;
Abstract

4. A new healthcare specific patient journey modelling tool;
5. Improved technology support for patient journey modelling.

The Patient Journey Modeling Meta-Methodology (PJM^3) delivers an overarching architecture on which to base healthcare improvement initiatives well beyond any currently in existence. PJM^3 allows for the definition of the healthcare provider strategy, in the form of Balanced Scorecards, and for these to be explicitly linked with operational process changes. PJM^3 also accommodates the inclusion of relevant legislation/policies and accreditation requirements, practice guidelines and patient needs into the process modeling activities.

PJM^3 and the Assessment Framework provided a foundation for the development of a new patient journey modeling tool designed specifically for the healthcare domain. The original patient journey modeling tool, PaJMa (pronounced ‘pajama’), explicitly includes a number of new dimensions not previously catered for, namely the inclusion of practice guidelines and patient needs. These dimensions are accommodated in PaJMa through the use of an innovative multi-layered modeling approach.

The research concepts and tools presented in this work are demonstrated via their application in an Australian primary care maternity service.

Case study results show that the new tools and techniques:

- allow for the rapid development of patient journey models that are easy to understand,
- enable ready recognition of areas of potential care variability,
- encourage disparate stakeholder communication,
- promote ownership of problems and their solutions, and
- allow for simple identification of required action plans.

Keywords: patient journey, patient journey model, patient flow, healthcare improvement, healthcare redesign, process modelling.
CHAPTER 1 INTRODUCTION

Health care is a highly complex system with many broken parts. The good news is that for every broken part in our system, there are remarkable examples of excellence — organizations that have overcome enormous obstacles to redesign the way patient care is delivered (IHI 2004, p.1).

Currently all healthcare process improvement initiatives are using patient journey modeling techniques from non-healthcare domains such as manufacturing, computing or business. In many cases healthcare improvement projects are using the constructs of these techniques as they were originally proposed and are faced with being unable to capture all of the design features required to deliver high quality patient-centric journeys that are safe, effective, timely and efficient.

This thesis presents an improvement architecture, in the form of a meta-methodology, aimed at addressing this significant issue – the lack of a patient journey modeling framework, designed specifically for healthcare. The architecture accommodates the particular nuances and inherent complexities associated with the redesign of patient-centric healthcare processes including performance measurement and feedback to management, thus promoting a culture of continuous process improvement.

The thesis will demonstrate the development of an original patient journey modeling meta-methodology supported by an innovative patient-centric patient journey modeling tool and an accompanying performance measurement database design for management decision support, all expressly designed for the healthcare domain.
Introduction

Specifically this work is about the improvement of work practices to achieve reduced care variability and higher quality outcomes thus delivering better results to patients at lower costs. This includes using best-practice guidelines, eliminating unnecessary bureaucracy, streamlining and minimising handovers between and across caregivers, improving IT support for workflows and information storage and retrieval, providing the right information to the right people at the right time, eliminating unnecessary work, reducing superfluous controls, empowering employees and getting it right the first time.

This research deals primarily with modeling the manner in which healthcare is delivered, that is ‘the system of care’. The underlying premise is that each aspect of clinical care is made up of multiple processes and combining these processes creates the ‘system of care’ for that particular task. Therefore unless one changes and improves the system there will not be an improvement in results, that is, outcomes. Berwick’s (1996) *Central Law of Improvement* states that “every system is perfectly designed to achieve the results it achieves”. This law implies that improvement in performance is not a matter of effort or just trying harder, but rather requires changes to the system of care (Berwick 1996; Wilson and Harrison 2002). Models based on these principles provide a framework to reduce the variability of care by helping to understand the relative significance of any one or related group of variables contributing to patient outcomes. Models also assist in building consensus among healthcare workers, as well as in the planning of interventions and improvements (Camann 2001).

Modeling of the multiple dimensions that contribute to the entire journey experienced by a patient within and across Health Care Organisation/s (HCOs) and the inherent complexity of their inter-relationship influences three specific aspects of the health care system (Donabedian 2005; Friedman and Wyatt 2006):

1. *Structure* of the health care system, including its environment, available equipment, required budgets and the number, skills and inter-relationships of staff.

2. *Processes* that take place during healthcare activity including clinical, administrative and management activities.
Introduction

3. Outcomes of health care for both individual patients and the community and the ongoing reputation and quality of care delivered by the health care provider and its staff.

The goal of patient journey modeling therefore is not the improvement of only one of these aspects at the expense of the others but the delivery of quality improvements in all three areas. This is achieved by taking a holistic approach to the patient journey modeling exercise via the consideration of multiple layers of information as included in the new patient journey modeling suite of tools developed as part of this research.

Several terms are used in the literature to refer to the concept of patient journey modeling (PJM) including: clinical pathways, optimising patient flow, clinical practice improvement and redesigning healthcare (NSW Department of Health 2002; IHI 2003; Haraden and Resar 2004; Szwarcbord 2005; UK Department of Health 2005; Jensen et al. 2006). This research uses the term ‘patient journey’ to include not only the flow or implementation of improved clinical practice but to encompass the complete spectrum of a patient’s experience for a given service.

Patient Journey Modeling is a patient-centric activity that details a patient’s progress through a healthcare system for a given service (NHS Modernisation Agency 2005; NHS Modernisation Agency 2005). Patient Journey Modeling (PJM) aims to improve patient safety and overall health care quality by reducing variability in the care process. It involves the analysis of the overall processes involved with the movement of a patient through a healthcare system, typically a hospital, and then analysing how this journey can be improved via:

- the removal of unproductive and excessive activities,
- the removal of process duplication,
- the introduction of evidence-based best practice,
- collecting required information only once,
- reducing the number of times a patient is moved,
- the application of integrated information technology and
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- improved communications between the patient, their carers and the clinicians involved with the journey itself.


All of this information is bought together in the form of a graphical process model or in healthcare terms a ‘Patient Journey Model’.

Patient Journey Models focus on the processes that a patient is involved with as they move through the HCO. A process is a continuous series of tasks, undertaken for the purposes of creating a specific output. The starting point and final output of the process should be as requested and used by either internal or external customers. Processes are the enabler of the organisations value chain and should focus on the customers output needs (Scheer 1998).

The Workflow Management Coalition defines a business process as:

A set of one or more linked procedures or activities which collectively realize a business objective or policy goal, normally within the context of an organizational structure defining functional roles and relationships (WfMC 1999, p.10).

It goes onto define business process definition as:

The representation of a business process in a form which supports automated manipulation, such as modeling or enactment by a workflow management system. The process definition consists of a network of activities and their relationships, criteria to indicate the start and termination of the process, and information about the individual activities, such as participants, associated IT applications and data (WfMC 1999, p.11).

It follows that Business Process Re-design is the alignment of a company’s processes to the needs and requirements of the market and includes the design, analysis and optimisation of processes as part of the continuous improvement loop (Hammer and Champy 1993; Scheer 1998).
This indicates that modeling the patient’s journey through a HCO cannot be conducted in a vacuum. Several contributing dimensions must also be considered and incorporated into the final workflow.

This is never more so important than in healthcare where ‘success’ depends mostly on the skills of the healthcare workers and their application of these skills in the given environment. The identification and inter-relationship of the tangible and intangible assets (contributing dimensions) of a given HCO must be captured and incorporated into the development of the overall patient journey modeling framework.

Dimensions identified as impacting the patient journey include:

- The healthcare provider strategy as affected by Government legislation/Accreditation/Provider Policy;
- The human and physical resource availability/needs;
- The Patient’s needs;
- Best practice guidelines;
- Administration requirements and procedures;
- Technological support;
- Organisational structure and;
- The metrics associated with measuring change in each of the above.

Seila (2005) suggests that developing health care models requires health system managers and care givers to collaborate with modelers. However he points out that this can be difficult due to the different cultures and values held by both groups. This necessitates a cross-discipline approach as employed by this research. The proposed work brings together several complimentary domains including information technology, organisational management and social science.

Research investigations focused on strategic objective development and balanced scorecards, process reengineering and modeling, workflow and workflow management systems, decision support systems, and socio/cultural assessment systems.
The innovative meta-methodology presented in this research is known as \( PJM^3 \) (the Patient Journey Modeling Meta-Methodology). The implementation of this new construct is supported by \( PJM^2 \) (the Multi-dimensional Patient Journey Modeling Conceptual Design) and \( PaJMa \) (a healthcare specific Patient Journey Modeling tool).

This suite of healthcare improvement tools uses Balanced Scorecards, as adapted by the Ontario Hospital Association, to define the Health Care provider strategy. Patient Needs assessments are used to highlight and analyse the patient population’s particular needs and circumstances. Relevant Practice Guidelines are identified and used as input to reducing care variability. These inputs are considered during the development of the patient journey models, which are built using ‘best-of-breed’ process reengineering and modeling techniques. Workflow systems are used to enact and monitor the defined patient journey, the movement of information within the organisational structure and the adherence to legislation, policy and professional body guidelines. Performance to targets is monitored and evaluated by decision support systems incorporating a feedback loop to the healthcare provider strategy.

More specifically contributions are made via the use of innovative techniques that help to visualise how a patient moves through the entire system (not just one department), bringing together the multiple dimensions required to improve patient flow at a holistic level and highlighting areas of waste and duplication at their source. In addition the new techniques provide a common base for all stakeholders thus encouraging interaction from all levels and types of stakeholders including patients and clinicians, promoting action plan ownership and supporting the definition of specifications for integrated information systems. The research also provides for the definition of the performance monitoring and evaluation criteria required for the development of the decision support systems that will provide feedback to management thus promoting a continuous process improvement culture.

The combination of these items within the meta-methodology enables links between the contributing areas to be established and the impact of their relationship and interaction to be monitored, evaluated and (if needed) further improved.
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The framework that forms part of the meta-methodology’s patient journey modeling component provides explicit dimensions that must be analysed and evaluated for their impact on the current and future patient journey. This provides succinct direction to the model creators and concrete justification of recommended changes to the current patient journey for management.

The remainder of this introductory chapter will highlight the issues and limitations relating to current healthcare process improvement methods and modeling techniques. These limitations lead to a discussion on the motivations for this research resulting in the definition of the research aims. Contributions to the knowledge domain follow along with an outline of the overall thesis structure.

1.1 Limitations of Process Modeling Methods for Patient Journey Redesign

Taking a holistic view of the patient journey shifts the improvement focus from the individual healthcare worker to all involved stakeholders and the system of care itself. Therefore improvement methods based on overall process improvement have a higher chance of success than those based on the ‘exhortation of individuals to try harder or to avoid error’ (Wilson and Harrison 2002).

Business Process Re-design and Modeling is the alignment of a company’s processes to the needs and requirements of the market and includes the design, analysis and optimisation of those processes as part of a continuous improvement loop. This involves three primary tasks:

- The capture of target customer requirements and critical success factors.
- The definition of the ‘warts-and-all’ current process flow.
- The re-alignment of existing business processes to the current demands of the market.

For all tasks, a method-based approach and a unified description language are essential. Questions such as “Who does what, in what sequence, what services are provided and which software systems are used in the process?” are critical.
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As part of the process analysis, organisational, structural and technological weak points in the processes are revealed and improvement potential is identified. The results of the analysis, combined with the corporate goals, are used to derive target processes, i.e. those processes that will in future help the company to create value (Hammer and Champy 1993; Scheer 1998).

Additional reasons for using process models are wide and varied and include (Scheer 1998):

- Optimisation of organisational change
- Capture and storage of corporate knowledge
- Production and utilisation of process documentation for ISO standard and other quality certifications
- Calculation of the cost of business processes
- Leverage of process information to implement and customise standard software solutions for workflow systems.

Such research indicates that a comprehensive process modeling method must consider not only the operational processes but also their link to the organisational strategy, workflow automation, integrated technology support and communication mechanisms for evaluating improvements. This is compounded in healthcare by further requirements to incorporate patient needs, practice guidelines and high levels of specialist knowledge into the mix.

To date the Healthcare domain lacks a design and modelling methodology specifically designed to support the requirements for redesigning patient journey practices from a patient-centric perspective. In addition, most of the current methods lack the facilities to align changes with the healthcare provider strategy or produce new process outputs that are appropriate for automated workflows or performance measurement by decision support systems.

During the 1990’s process modeling techniques began to emerge in the manufacturing, business and computing fields (Womack et al. 1990; Booch 1994; Leymann and Altenhuber 1994; Scheer 1999).
Today there are numerous process modeling methods/techniques available but only a limited number are being endorsed for healthcare redesign and none have been designed specifically for the healthcare domain. In fact all projects thus far have adopted methodologies from other disciplines namely: business, manufacturing and computing (Heyamoto 2002; Browne et al. 2003; Wysocki Jr 2004; Young et al. 2004; Bassham 2005; Ben-Tovim 2005; Gospodarevskaya et al. 2005; Gowland 2005; Schweiger et al. 2005) as an example. The four most commonly used process modeling methods/techniques used in the projects referenced above were:

- Lean Thinking;
- Six Sigma;
- Flowcharts in the form of Swimlanes; and
- ARIS.

Of these the primary method employed in redesigning care processes is Lean Thinking, a method developed to improve car manufacturing processes in Japan after WWII (Womack et al. 1990; Womack and Jones 2003; IHI 2005; NHS Modernisation Agency 2005). Lean Thinking is the tool of choice for the Institute of Healthcare Improvement, the leader in the improvement of health care throughout the world, and is promoted for use with their ‘Model for Improvement’ (MFI). The MFI provides a framework for developing, testing and implementing changes that lead to improvement and is the dominant healthcare improvement method in the United States (IHI 2003; IHI 2005). The MFI is also the method of choice for the UK’s NHS Institute for Innovation and Improvement, with this program also supporting Lean Thinking as well as process maps in the form of flowcharts (NHS Modernisation Agency 2005; NHS Modernisation Agency 2005). Lean Thinking does not consider the organisation’s strategy or provide mechanisms for producing workflow automation specifications. It also lacks the facility to relate identified measurement criteria to appropriate database designs for performance evaluation.
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Such approaches mean that methods/techniques from non-medical fields have been driving the majority of healthcare redesign activities and little new work has been conducted on the development of new techniques or how the existing methodologies being used can be enhanced to provide better support for the quality improvements demanded of Healthcare systems worldwide.

Although process modeling techniques such as Lean Thinking and ARIS have enhanced their process modeling software to include healthcare relevant icon libraries, the basic constructs of the methods supporting the tools are unchanged. This often sees the models becoming confused and sometimes very difficult to read. Such issues reduce the chances of radical improvements as stakeholders become bogged down with trying to understand the models themselves instead of being able to concentrate on the real issue of redesigning the system of care.

Notwithstanding the software enhancements above, Lean Thinking and ARIS both fail to incorporate patient needs, discontinuities of care or patient handovers. All identified as critical to the delivery of safe, high quality healthcare (Committee on Quality of Health Care in America 2001).
1.2 Research Motivation

“Improved management of organizational processes can reduce the risk of negative patient outcomes resulting from delays in the delivery of care, treatment and services” (JCAHO 2004, p.1).

The focus on patient safety and the delivery of improved health care came to the fore in 1999, when the United States Institute of Medicine (IOM) produced ‘To err is human: Building a safer health system’. This report resulted in huge public attention on the crisis in the US health care system and the apparent lack of patient safety. The report suggested that as many as 98,000 people were dying each year in US hospitals due to medical injuries, that is, injuries incurred during the patient’s hospital stay (Kohn et al. 1999).

However, as early as 1995, a study into 14,000 hospital admissions in two Australian States found that up to 16% of patients were killed or injured as a result of their treatment rather than their original medical condition (Wilson et al. 1995). The then Federal Health Minister stated in Parliament that if these figures were extrapolated to a national level, that as many as 230,000 patients could be involved in preventable adverse events with up to 14,000 of these being fatal (Goddard 2003).

Further work carried out by the IOM produced a second report, ‘Crossing the quality chasm: A new health system for the 21st century’ which was released in 2001 (Committee on Quality of Health Care in America). This report outlined a way forward for the US health system and outlined six (6) overarching ‘Aims for Improvement’:

- **SAFE**: Avoid injuries to patients from the care that is intended to help them.
- **EFFECTIVE**: Match care to science; avoid overuse of ineffective care and underuse of effective care.
- **PATIENT-CENTERED**: Honor the individual and respect choice.
- **TIMELY**: Reduce waiting for both patients and those who give care.
- **EFFICIENT**: Reduce waste.
- **EQUITABLE**: Close racial and ethnic gaps in health status.
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These six aims have formed the basis for change programs throughout the US health system and the impetus for healthcare delivery reviews worldwide.

As an example in point, the Australian Federal Government spent in excess of $40 billion on the improvement of Health and Aged Care during the 2003-2004 financial year. This equals 20% of the total Federal budget and equates to approximately $2000- for every man, woman and child in this country (Abbott 2004). In addition to Federal health funding, each State has allocated its own substantial Healthcare budget to improve the quality of healthcare delivery (NSW Department of Health 2004; Queensland Department of Health 2004; South Australian Department of Human Services 2004; Victorian Department of Human Services 2004; Western Australia Department of Health 2005).

The significance of this issue is also acknowledged on the world stage as demonstrated by countries such as the United Kingdom (HM Treasury 2004) and Canada (Canadian Department of Finance 2004) who have nominated healthcare improvement as a priority issue along with the allocation of substantial federal budgets for quality improvement initiatives.

Unfortunately even with the increased professional and public awareness of this problem, radical improvements do not abound. In fact recent studies by the Institute for Healthcare Improvement (IHI) estimate that up to 15 million incidents of medical harm still occur in U.S. hospitals each year (IHI 2006).

The Institute for Healthcare Improvement is a not-for-profit organisation leading the improvement of health care throughout the world. Founded in 1991, IHI is a ‘catalyst for change, cultivating innovative concepts for improving patient care and implementing programs for putting those ideas into action’. Thousands of health care providers, including many of the finest hospitals in the world, participate in IHI’s groundbreaking work (IHI 2006).
In December 2004, the IHI launched the 100,000 lives campaign. This campaign sought to actively reduce the number of adverse deaths in U.S. hospitals. Using six evidence-based interventions, healthcare professionals at more than 3000 care sites in the U.S. averted over 122,000 patient deaths in an 18-month period. This initiative represented the largest improvement effort ever undertaken by the healthcare industry in recent history and indicates that removing process variability for a given patient journey is an important activity that will assist in improving outcomes (IHI 2004; Mitka 2006).

Continuing on from the 100,000 lives initiative and in a bid to further increase the impetus for healthcare providers to improve services, the IHI announced, with the support of prominent leaders in American health care, a new national campaign to dramatically reduce incidents of medical harm in U.S. hospitals. Launched in December 2006, “the ‘5 Million Lives Campaign’ asks hospitals to improve more rapidly than before the care they provide in order to protect patients from five million incidents of medical harm over a 24-month period, ending December 9, 2008” (IHI 2006, p.1). It is proposed that these targets will be met through the introduction of 12 standardised care improvements in the participating hospitals (IHI 2006).

Such initiatives not only improve patient outcomes but also improve patient flow through the system, as the correct treatment is being delivered the first time and ‘re-work’ is being eliminated. This is supported by another IHI report: ‘Optimising Patient Flow’, that states that “the key to improving flow lies in reducing process variation that impacts flow”. It goes onto say that “while some variability is normal, other variation is not and should be eliminated” (IHI 2003, p.1).

The focus on Patient Flow as a significant contributing factor to healthcare improvement success reached critical mass on January 1 2005. On this date a new Joint Commission “Leadership” Standard, LD.3.10.10, became effective for all accredited hospitals in the U.S. This standard calls on “leaders to develop and implement plans to identify and mitigate impediments to efficient patient flow throughout the hospital”.

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Accompanying rationale states that “managing the flow of patients through their (leaders) care is essential to the prevention of patient crowding, a problem that can lead to lapses in patient safety and quality of care” and that “to understand the system implications of the issues, leadership should identify all of the processes critical to patient flow through the hospital system” (JCAHO 2004, p.14).

However, Resar (2006) suggests that the playing fields are not equal when evaluating improvements in healthcare and non-healthcare domains. For example he states that the focus on failure and the analysis of defects in industries such as manufacturing is at a different level due to the fact that these types of industries are already working with core processes that operate correctly more than 90% of the time. Whereas in healthcare the baseline starting point for defective core processes could be as high as 50%. This indicates that improvements will be possible using a variety of process improvement methods and this is why we have seen some successes with methods such as Lean Thinking and Six Sigma. It does not support the premise however that the methods currently being employed provide the required level of support for ongoing and all encompassing, healthcare system improvement.

Jensen et al. (2006) state that opportunities for healthcare improvement lie in taking a “leadership approach that involves quality control and quality improvement and incorporating it into the design, production, and operations of the healthcare system” (p.67). They suggest that the top strategies for improving flow are derived from the areas of quality improvement, information technology and clinical medicine and that innovations with the highest impact are likely to occur where these three domains overlap as shown in Figure 1.1.

The research addressed in this thesis accommodates each of these domains and one of the key foci is the relationship and interactions between these and other identified dimensions seen as critical success factors for patient journey modelling improvement.
Therefore if we take all of the above and in particular, the aims of the IOM and JCAHO, as a key starting point for healthcare improvement, the fundamental question then becomes: What support should improvement tools and techniques provide to enable such improvements to be realised within healthcare?

1. **Alignment of organisational change to the Healthcare Provider Strategy.**
   Research regarding the criticality of aligning organisational change with the business strategy has been occurring for almost 30 years (Miles et al. 1978; Henderson and Venkatraman 1991). Such alignment is equally relevant in healthcare and indicates that all improvement activities must look to align the process improvement goals and measurements with the healthcare provider strategy. The healthcare provider strategy in turn, is not developed in isolation but takes significant input from Government legislation, accreditation standards and professional body policy.

2. **Incorporation of Practice Guidelines and Patient Needs in the Redesigning Care Activity.**
   At an operational level, practice guidelines and patient needs also come to the fore and are a critical input to the redesign process. The existing designs of the predominant healthcare process modeling tools, fail to take these two issues into consideration.

Process model outputs must also be cognisant of the requirements for technological support for the automation of new workflows and performance measurement and evaluation systems. Technology is a key enabler of organisational change and existing process modeling tools used in healthcare are deficient in their ability to develop flexible process output specifications.

This situation forms the foundation for this research work and has led to the development of an original patient journey modeling meta-methodology that can be used to assess the support provided by the tools and techniques chosen by healthcare improvement teams or to develop new tools designed explicitly for the healthcare domain. The meta-methodology is complimented by an accompanying tool suite, which includes a new healthcare specific patient journey modeling tool. The research further enhances the meta-methodology’s application through the provision of a supporting database design for organisational learning and ongoing performance monitoring and evaluation.
1.3 Research Hypotheses

The purpose of this research was to investigate the requirements of healthcare improvement initiatives in relation to the modeling of the processes of care involved in a given patient journey. This included analysis of existing patient journey process modeling methods and associated enhancement suggestions, along with criteria for the development of a new breed of techniques designed specifically for healthcare from the ground up.

Development of any new techniques must look to use technology as an enabler of change such as providing for the specification of automated workflows and database designs for performance measurement and evaluation systems.

When taken into consideration with the three ‘support questions’ in Section 1.2, the primary hypotheses for this research were that:

<table>
<thead>
<tr>
<th>1.</th>
<th>A generic framework can be defined to outline the key components required to support safe, high quality patient journey improvements, including strategy and process definition, workflow support and performance measurement and evaluation criteria.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.</td>
<td>Such a framework can accommodate the nuances and complexities associated with healthcare redesign in particular the inclusion of patient needs and practice guidelines.</td>
</tr>
<tr>
<td>3.</td>
<td>The framework can be used to evaluate existing process modeling techniques employed in healthcare and/or to develop new healthcare specific process modeling techniques.</td>
</tr>
<tr>
<td>4.</td>
<td>Components of the framework can be explicitly linked and enabled by readily available technology.</td>
</tr>
</tbody>
</table>
1.3.1 Specific Scope Exclusions

Simulation Modeling

The two main reasons for undertaking a process modeling project are to describe a process flow or optimise an implementation solution. Optimised implementation solutions require the process analysis to be supported by formal evaluation tools such as simulation. This requires unambiguous parsable process descriptions that are far too detailed for projects of a descriptive nature. This research focuses on process modeling for descriptive purposes and as such process modeling for simulation purposes (i.e.: Simul8) are outside the research scope.

Research on simulation modeling in healthcare is well covered in publications by Brailsford (2005), Klein et al. and Harper and Gamlin (2003) as a small example.

Patient Volume Variability Analysis

Within the Healthcare Improvement domain there is a growing body of knowledge concerning the statistical analysis of variations in patient traffic/volumes. These works are focused on measuring and understanding peaks and troughs in patient numbers over time. Techniques such as forecasting, demand-capacity management, queuing theory and theory of constraints are well established in the service industry and over recent years a number of healthcare improvement researchers have been applying these techniques to patient flow problems with some good results. As this research is focused on process modeling for the purposes of improving the system of care, the statistical analysis of patient volumes and traffic variations is not within the scope of this research.

Further information on smoothing patient traffic including the forecasting and prediction of patient volume variations is well covered by leading Healthcare Improvement researchers such as Litvak et al. (2005; 2005), Harper and Gamlin (2003) and Jensen et al. (2006).

References to where this material can supplement the contributions of this research will be made as appropriate.
1.4 Research Contributions

The original contributions of this thesis enhance the field of healthcare improvement by providing new theoretical constructs for the conduct of patient journey modeling projects. More importantly the major contributions of this research provide practical tools that can be used by healthcare staff with little or no previous process improvement experience to improve the consistency and quality of outcomes for patient journey redesign initiatives.

Contributions are made in the following areas:

PROVISION OF A DOMAIN SPECIFIC IMPROVEMENT ARCHITECTURE:

Significantly the Patient Journey Modeling Meta-Methodology (PJM³) delivers an overarching architecture on which to base healthcare improvement initiatives well beyond any currently in existence. PJM³ allows for the definition of the healthcare provider strategy, in the form of Balanced Scorecards, and for these to be explicitly linked with operational process changes. PJM³ also accommodates the inclusion of relevant legislation/policies and accreditation requirements, practice guidelines and patient needs into the process modeling activities. Resulting process specifications can be output to workflow management systems for automated workflow support. Performance measurement criteria can be defined for inclusion in Decision Support Systems thus providing facilities to evaluate process change and feedback results to management for ongoing process improvement. The development of PJM³ provides a solution to research hypotheses 1 and 2.

AN ASSESSMENT FRAMEWORK FOR PROCESS MODELING TOOLS:

PJM³ also establishes the basis for the development of a ‘Process Modeling Assessment Framework for Healthcare’ (PMAF4HC or simply the Assessment Framework) as required by research hypothesis 3. This allows healthcare improvement managers to understand the limitations of the tools they are using so that contingencies can be developed or new tools sourced.
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This framework was used to assess four process modeling techniques currently being used for healthcare improvement and to suggest enhancements to those tools. The Assessment Framework was also a significant contributor to the development of a new patient journey modeling tool as discussed in a later point.

A MULTI-DIMENSIONAL CONCEPTUAL DESIGN FOR HEALTHCARE IMPROVEMENT:

Using the core concepts of the improvement architecture above as a foundation, a generic patient journey model design was developed. The Multi-Dimensional Patient Journey Modeling Conceptual Design or PJM² is abstracted directly from PJM³, and provides a portal through which to view the complex environment of healthcare improvement. PJM² takes the multiple facets involved in redesign projects and segments them into logical subject areas. Such a conceptualisation can be used in a variety of areas either as a standalone tool or in combination with other tools such as the Assessment Framework. Potential uses include evaluating existing patient journey modeling tools, constructing new domain specific patient journey modeling tools, developing models of the current and future patient journey and/or selecting supporting technology. For example, when developing the future patient journey model, each subject area can be considered as a single entity or combined with another, depending on the audience involved and the processes being analysed. This prevents those developing the models becoming overwhelmed with information thus allowing them to focus on specific parts of the problem domain. In this way the overall patient journey model is built up gradually over time therefore facilitating progressive understanding of the entire journey continuum.

The development of PJM² provides additional support for the resolution of research hypotheses 1, 2 and 3.

A NEW HEALTHCARE SPECIFIC PATIENT JOURNEY MODELING TOOL:

This research contribution used PJM¹, the Assessment Framework and PJM² as the benchmark for the development of a new patient journey modeling tool designed specifically for the healthcare domain.
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The new patient journey modeling tool, *PaJMa* (pronounced ‘pajama’), explicitly accommodates a number of new dimensions not previously catered for, namely the inclusion of practice guidelines and patient needs. Patient needs and practice guidelines are included in *PaJMa* through the use of a multi-layered process modeling approach. Colour-coding is used to differentiate the contributing layers, allowing stakeholders to readily identify the myriad of different components associated with redesigning the patient journey at a holistic level.

The tool also introduces innovative techniques for visualising patient flow problems from a multi-dimensional perspective, allowing the patient journey to be ‘sliced and diced’, that is developed and viewed from a variety of perspectives, thus providing for diverse stakeholder input and discussion.

The development of the *PaJMa* tool addresses research hypotheses 2 and 3.

**IMPROVED TECHNOLOGY SUPPORT FOR PATIENT JOURNEY MODELING:**

In response to hypothesis 4, the healthcare provider strategy can be defined using Balanced Scorecards with each Scorecard perspective being specified using the *Balanced Scorecard XML standard* (Balanced Scorecard Collaborative 2001). XML is a widely available markup language used for information delivery across disparate applications and can remove many of the technology and software barriers that currently exist when transferring performance management and strategy related information between applications and across enterprises. XML in the form of the Workflow Management Coalition’s (WfMC) *XML process definition language (XPDL)* (WfMC 2005) can also be used to specify workflow requirements as identified during new patient journey analysis activities. This facilitates the automation of required workflows in any XML compatible workflow management system. To accommodate all of the dimensions included in *PaJMa*, extensions to the *BSC XML* and WfMC *XPDL* were required. Proposed extensions were developed and are described, along with relevant examples from the case study, in Appendices B and C respectively.
$PJM^2$ also provides the foundation for the development of an original multidimensional database design supporting the capture of performance measurement and evaluation criteria. Such criteria can be implemented as part of a Management Decision Support System (MDSS) to assist organisational learning and to assess the degree of improvement that can be attributed to process changes made as a result of new patient journey model implementations. MDSS outputs can also be used by management as justification for ongoing process improvements and provide a feedback loop to the healthcare provider strategy.

In summary the new meta-methodology ($PJM^3$) presents an innovative multidimensional healthcare improvement architecture that allows for the inclusion of the healthcare provider strategy in the form of Balanced Scorecards, along with the ability to accommodate relevant legislation/accreditation requirements, practice guidelines and patient needs. The meta-methodology formed the foundation for the development of a new Assessment Framework that can be used to evaluate existing process modeling tools or to develop new patient journey modeling tools. $PJM^3$ was also used as the benchmark for the abstraction of a patient journey modeling conceptual design. This conceptual design known as $PJM^2$, provides a straightforward technique for dividing the complexities of patient journey modeling projects into manageable dimensions that can be integrated over time. These contributions led to the development of a new healthcare specific patient journey modeling tool, PaJMa. The PaJMa tool provides an innovative approach to the graphical representation of the system of care and is supported by an original database design that facilitates performance measurement of implemented changes in the form of a Management Decision Support System. Outputs from the patient journey modeling tool also provide process definitions that can be used as direct input to workflow automation activities that are explicitly linked and enabled by readily available technology.
The above contributions provide solutions to the research hypotheses posed in section 1.3 as follows:

1. A meta-methodology (PJM$^3$) facilitating the definition of safe, high quality patient journey improvements can be developed. The meta-methodology can specifically accommodate the healthcare provider strategy, practice guidelines, patient needs, patient journey processes, related workflows and performance measurement criteria.

2. An assessment framework for the purposes of evaluating the effectiveness of existing process modeling techniques can be developed. The meta-methodology and assessment framework can also be used to develop new healthcare specific process modeling tools.

3. A multi-dimensional conceptual design (PJM$^2$) can be abstracted from the meta-methodology thus providing a straightforward technique for segmenting the complexities associated with the definition of high quality future patient journeys.

4. Practice guidelines and patient needs can be explicitly included in patient journey models through the introduction of a multi-layered modeling approach as in PaJMa.

5. Components of the meta-methodology, in particular ‘healthcare provider strategy’ to ‘process’ and ‘process’ to ‘workflow’ and ‘performance measurement’ can be explicitly linked using readily available technology such as XML.
1.5 Research Approach

The research used a constructive research process enriched by aspects of a participatory action research environment. The instantiation of the meta-methodology involved the primary care maternity service offered by Ryde Hospital’s Maternity Department. Participants included the management, staff and patients and the caseload midwife team within Ryde hospital as well as the external interfaces Ryde has with its referral hospitals such as Royal North Shore and other units within the Healthcare value stream for a given patient.

Constructive research is an established research method that has been used in the management accounting, information systems, computer science and medical domains for several years (Kasanen and Lukka 1993; Curry and Simpson 2000; Shaw 2001; Shapiro and Shapiro 2003). Constructive research aims to produce novel solutions to explicit problems which have both practical and theoretical components (Lassenius et al. 2001). All human artifacts such as models, diagrams, plans, organisation structures, commercial products or information system designs can be labeled as constructs. Explicitly

The method produces innovative constructs, intended to solve problems faced in the real world and, by that means, to make a contribution to the theory of the discipline in which it is applied (Lukka 2003, p.1).

Figure 1.2. Elements of Constructive Research (Lukka 2003)
The primary objectives of constructive research are to produce a construct that:

1. has practical application and is functionally correct (of a quality standard)
2. is cost effective during its development and use
3. is timely in its delivery

The constructive research process is characterised by six phases, which may be iterative and vary in order depending on the case under review:

1. **Find a practically relevant problem**
   The problem of using a non-industry standard design and modeling methodology for patient journeys is becoming increasingly relevant and the push for quality improvements in healthcare is consistently increasing. Measurement of the multiple dimensions associated with healthcare process improvement also requires attention.

2. **Obtain a general and comprehensive understanding of the topic area and problem**
   Literature review and empirical analysis provided the main basis for understanding of the problem domain. This was further enhanced by collaborative workshops with the Ryde midwifery staff, management and patients.

3. **Innovate, ie: construct a solution idea**
   Design of the meta-methodology, new patient journey modeling tool and accompanying efficacy and efficiency criteria created a novel construct for patient journey redesign initiatives

4. ** Demonstrate the solution works**
   The resulting construct is demonstrated via its application to the design and modelling of the midwifery practices of the obstetric unit at Ryde hospital

5. **Show the theoretical connections and the research contribution of the solution concept**
   The case study outputs clearly demonstrate the research contributions made by the meta-methodology and measurement framework to the areas of health informatics and information systems.

6. **Examine the scope of the applicability of the solution**
   Investigate the relevance of the new construct in other areas of healthcare.
Introduction

Aspects of a participatory action research environment enriched the above constructive research process to the extent that research domain users were included in phases 2, 3 and 4. The research team involved in the case study project included myself as the primary researcher, senior management and the midwifery staff of Ryde hospital, as well as a number of women (patients) involved in the Ryde Midwifery Group Practice (both pre and post introduction). External Healthcare workers and professional bodies contributed to the analysis and interpretation of the findings and the ensuing ‘future patient journey’ model.

This introduced an idiographic line of enquiry by collaborating with the actual subjects who are at the core of the research and including them in the analysis process as well as the actual change experiences of the case study environment. The variety of data sources ensures triangulation of the results and provided cross-referenced justification for the introduction of changes to improve the consistency and quality of the obstetric patient journeys at Ryde.

Baskerville (1999) also states that systems development methodologies are a key area of importance for the application of action research (Baskerville 1999). As this research assessed the degree of support provided by several development methodologies currently employed in healthcare process modeling, it was possible to highlight potential changes to these methods to enhance their overall levels of support for the healthcare domain. Baskerville and Wood-Harper (1996) claim that action research is one of the few valid research approaches that can be legitimately employed to study the effects of specific alterations in systems development methodologies in human organisations (Baskerville and Wood-Harper 1996).

It should also be noted that as this research deals with complex social environments, all interactions amongst the participants must be considered as a complete whole. If the research area was broken down into its various sub-components and they were studied individually, little benefit would accrue to the healthcare and information systems domains as it is the interaction between the individual components that will yield the greatest insights. It is also appropriate as changes were suggested and introduced during the case study project and it is the observation of the effect of these interventions that produced meaning and justification to the development of the
Introduction

meta-methodology, the improved patient journey/s at Ryde and the application of the devised approach to the Healthcare domain in general.

As this type of research generates an amount of ‘soft’ empirical material, a qualitative analysis approach was also employed. This applied to the review of policy and documents, interviews with project participants, the feelings and decisions made by the midwives and the women (and their partners) that they were involved with and my own reactions and interpretations (Myers 1997). Quantitative analysis was applied to other aspects of the measurement framework that the meta-methodology needed to incorporate, such as service level targets, resource usage and associated costs.

The Maternity Department at Ryde Hospital was used to demonstrate the proposed meta-methodology and new patient journey modeling tool. This was achieved by modeling a woman’s journey, through the existing obstetric environment, using several process modeling methods that are considered appropriate for use in the redesign of patient healthcare. Four (4) process modeling methodologies were used to model the patient journey/s and highlight the degree of support for the proposed meta-methodology. The process modeling methods used and the rationale behind their inclusion are shown in Table 1.1.

<table>
<thead>
<tr>
<th>Process Modeling Method</th>
<th>Rationale for inclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lean Thinking</td>
<td>Is a supported process modeling technique of the US Institute for Healthcare Improvement and is extensively used in current and previous projects conducted by the National Health Service in the UK. Also being used by a number of redesigning care sites in Australia (Patient Flow Collaborative: Victorian Department of Human Services 2004; Ben-Tovim 2005). Software support in the form of enhanced healthcare icon libraries is available.</td>
</tr>
</tbody>
</table>
UML – BPMN  |  UML forms the basis of many process-modelling techniques and is the language being used to develop the HL7 reference model for healthcare messaging. Business Process Modelling Notation (BPMN) is UML’s recommended business process modelling method and is heavily reliant on flowchart type models in the form of Swimlanes (Object Management Group 2006).

ARIS  |  One of only two toolsets purported to support the healthcare domain (IDS Scheer 2004). Evolved from a widely used process modelling technique in Europe. Original product claimed to be market-leader in business process modelling tools (Davis 2001). Includes healthcare icon libraries.

Six Sigma  |  Used widely in the business and manufacturing industries. Now being used in several areas of healthcare improvement. Incorporates strict quality measures (Sodhi and Sohdi 2005; Wing et al. 2005; iSixSigma Healthcare 2006).

Table 1.1. Design and Process Modeling Methodologies Included in this Research
1.6 Thesis Overview

The remainder of the thesis structure is as follows.

| Chapter 2 and Chapter 3 | Contain the research domain literature review divided into two parts. Chapter 2 deals with the logical side of modeling the current patient journey and designing the new and improved patient journey. It looks at process reengineering in non-healthcare domains, the key drivers for change and major change agents within the health arena. Chapter 3 deals with the technology required to support such redesign activities within the healthcare domain. |
| Chapter 4 | Based on the open research questions bought out in Chapters 2 and 3, chapter 4 details the development of a new healthcare specific multidimensional improvement architecture in the form of a patient journey modeling meta-methodology known as \( PJM^3 \). |
| Chapter 5 | Using \( PJM^3 \) as a benchmark, an innovative Process Modeling Assessment Framework for Healthcare is proposed. This Framework can be used to assess the level of support provided by existing process modeling tools or as a baseline for the development of new healthcare specific patient journey modeling tools. The Assessment Framework is used to evaluate the four process modeling methods/techniques discussed in section 1.5 and to suggest improvements to these methods in their support of patient journey modeling. The assessment uses the thesis case study to describe an improvement environment and for the development of the associated patient journey models. |
| Chapter 6 | Using the core concepts of \( PJM^3 \), as a foundation, a generic patient journey model design was developed. The Multi-Dimensional Patient Journey Modeling Conceptual Design or \( PJM^2 \) provides a portal through which to view the complex environment of healthcare improvement. This chapter outlines the conceptual design and describes each of the dimensions and their relationship to patient journey modeling. |
| Chapter 7 | Leveraging the artifacts in chapters 4, 5 and 6, this chapter presents an original healthcare specific patient journey modeling tool. The new modeling tool is known as PaJMa (pronounced pajama) and is demonstrated via the primary care maternity case study conducted through Ryde Hospital, Australia. |
| Chapter 8 | In considering the implementation of the thesis proposals detailed in the previous four chapters, Chapter 8 outlines the improved technology support required to enable \( PJM^3 \), \( PJM^2 \) and PaJMa. This includes the XML definition examples for workflow automation as well as a multidimensional database design for a management decision support system for the analysis of initial patient journey model enhancements and ongoing quality improvements. |
| Chapter 9 | This chapter summarises the original contributions of the research including the impact the thesis proposals may have on the healthcare improvement landscape and the opportunities for future work. |
CHAPTER 2
LITERATURE REVIEW - PART A

2.1 Introduction

Chapters 2 and Chapter 3 take the form of a literature review on the key areas of research relevant to the Thesis topic. This research deals primarily with modeling the manner in which healthcare is delivered, that is ‘the system of care’. The underlying premise being that each aspect of clinical care is made up of multiple processes and combining these processes creates the ‘system of care’ for a particular task. Therefore unless you change and improve the system there will not be an improvement in results, aka, outcomes (Berwick 1996; Wilson and Harrison 2002).

The subject areas discussed are relevant to improving the ‘system of care’ and include process improvement in non-healthcare domains, process improvement in healthcare, linking change to healthcare strategy and the technology support required for healthcare process improvements. The review of each research area concludes with an assessment of the impact that the research area has had, or is having, on the design of the thesis outcomes.

This chapter (Chapter 2) will consider process improvement in relation to the patient journey and linking such changes to the healthcare strategy. Chapter 3 will supplement this with a further review on how technology can be used to support patient journey redesign implementations. The remainder of this introduction will deal with the contents of Chapter 2 only.
Chapter 2 is relevant to research hypotheses 1, 2 and 3, through the review and critique of current literature involving techniques presently used to develop patient journey models in healthcare. This review also considers if such techniques adequately accommodate the complexities associated with the provision of safe, high quality patient journeys that explicitly link provider strategy, process definition, workflow support and performance measurement and evaluation criteria and that are cognisant of patient needs and acknowledged practice guidelines.

These issues are open research questions as the constructs and methods developed for process improvement in a number of non-healthcare domains such as business, computing and manufacturing are the key drivers in the healthcare process improvement arena at the current time. To this end it is pertinent to review the origins of such other work and position its influence on today’s activities within the healthcare domain.

The Chapter begins with a review of the origins of process modeling and its use within non-healthcare domains. The Chapter then moves onto examining the current environment surrounding process improvement in healthcare and analysing some of the key historical events that have shaped that environment. The concepts of process modeling in the form of patient journey models are discussed and influential improvement initiatives are situated.

The Healthcare Strategy section discusses a key contributing factor of this research: the ability to align the healthcare provider’s strategy with patient journey improvements through the use of Balanced Scorecards. The origins of Strategy Analysis and the development of the Balanced Scorecard approach are discussed and positioned in the context of this research.
2.2 Business Process Improvement

2.2.1 Origins and Methodology
The principles of business process quality improvement, redesign, innovation, or reengineering have existed for over 30 years (Juran 1974; Hammer 1990; Davenport 1993; Hall et al. 1993; Caron et al. 1994). Acknowledged ‘fathers’ of the quality movement, Jospeh Juran and W.E. Deming started their work shortly after WWII, mainly in Japan, and their philosophies are still taught as core topics in many business and management courses worldwide. Another significant contributor to the quality initiative was Malcolm Baldrige and organisations still strive to win the prestigious namesake awards of Deming and Baldrige to this day (Juran 1974; Deming 1986; NIST 2001).

The primary focus of these and other works is that by improving quality across the organisation, increased market leadership and thus profits will ensue. There is significant agreement that to achieve such redesign outcomes process improvement projects must incorporate:(Davenport et al. 2003)

- “Radical redesign and improvement of work practices,
- Attacking broad, cross-functional business processes,
- Stretch goals of order-of magnitude improvement,
- The use of IT as an enabler of new ways of working.”

A number of business projects have indeed recorded significant improvement outcomes (Hammer 1990; Hall et al. 1993; Hammer and Champy 1993; Caron et al. 1994) and thus raised the profile of business process redesign in research circles promoting the introduction of variations and new quality improvement techniques and methods. Several quality improvements movements have taken centre stage over the last quarter century including Total Quality Management (TQM), ISO certification, Business Process Reengineering (BPR), Lean Manufacturing and Six Sigma (Womack et al. 1990; Hammer and Champy 1993; Motorola University 1994; Smith 1999; ISO 2007).
2.2.2 Process Modeling

A process is a continuous series of tasks, undertaken for the purposes of creating a specific output. The starting point and final output of the process should be as requested and used by either internal or external customers (Scheer 1998).

The Workflow Management Coalition defines a business process as:

*A set of one or more linked procedures or activities which collectively realise a business objective or policy goal, normally within the context of an organisational structure defining functional roles and relationships* (WfMC 1999, p.10).

It goes onto define business process definition as:

*The representation of a business process in a form which supports automated manipulation, such as modeling or enactment by a workflow management system. The process definition consists of a network of activities and their relationships, criteria to indicate the start and termination of the process, and information about the individual activities, such as participants, associated IT applications and data* (WfMC 1999, p.11).

*Business Process Re-Design* is the alignment of a company’s processes to the needs and requirements of the market and includes the design, analysis and optimisation of processes as part of the continuous improvement loop (Hammer and Champy 1993; Scheer 1998). This involves three primary tasks:

- The capture of target customer requirements and critical success factors.
- The definition of the ‘warts-and-all’ current process flow.
- The re-alignment of existing business processes to the current demands of the market.

As part of the process analysis, organisational, structural and technological weak points in the processes are revealed and improvement potential is identified. The results of the analysis, combined with the corporate goals, are used to derive target processes, i.e. those processes that will in future help the company to create value (Hammer and Champy 1993; Scheer 1998).
These tasks are represented by a *Process Model*.

*A process model is an abstract description of an actual or proposed process that represents selected process elements that are considered important to the purpose of the model and can be enacted by a human or machine* (Curtis *et al.* 1992, p.75).

During the 1990’s process modeling methods/techniques began to emerge in the manufacturing, business and computing fields (Womack *et al.* 1990; Booch 1994; Leymann and Altenhuber 1994; Karagiannis *et al.* 1996; Scheer 1999; Object Management Group 2006). Some of these methods were designed for a specific industry such as manufacturing (Lean) and some were more generic in nature (UML).

Irrespective of the type of industry for which a process modeling method is created, all methods share a common composition. Firstly there is an overarching set of generic concepts that guide the overall design and development activities and govern the structure of the deliverables. This is known as the *process meta-level*. At a lower level of abstraction is the actual *process model*, which describes the way things are or will be done and the flow of the processes involved. At the lowest level are *development runs* that represent how the processes will be implemented, that is the execution design (Rolland 1993). This construct is shown in Figure 2.1.

![Figure 2.1. Differing Levels of Process Abstraction (Rolland 1993)](image)

The two main reasons for undertaking a process modeling project are to describe a process flow or optimise an implementation solution (Williams 2000).
Optimised implementation solutions require the process analysis to be supported by formal evaluation tools such as simulation. This requires unambiguous parsable process descriptions that are far too detailed for projects of a descriptive nature. This research focuses on process modeling for descriptive purposes and as such process modeling for simulation purposes (ie: Simul8) are outside the research scope.

McGregor (2002) and McGregor and Edwards (2005) evaluated several process modeling methods in light of their ability to capture and represent the business strategy through business performance indicators. McGregor’s earlier work went on to develop a technique for supplying this information to both workflow management software and the decision support system. McGregor’s work provides the foundation of the workflow architecture component being used in this research and aided in the development of some of the evaluation questions used in the Assessment Framework.

Other comparisons of business improvement methods have been conducted but these have primarily focused on the workflow aspect of the products. These works have provided evaluation frameworks for workflow management systems and have not primarily considered the representation of business requirements on the process model (Berger et al. 1997; Rosemann and zur Muehlen 1998; Shi et al. 1998; zur Muehlen 1999).

None of the above work deals with comparing process models within the healthcare domain.

2.2.3 Conclusions and Implications for Patient Journey Modeling Research

Process modeling for the purposes of business reengineering has been used successfully in business, computing and manufacturing environments for many years. Interest in the use of such techniques in the healthcare improvement domain has been growing steadily in the recent past. Key questions exist however on how well these techniques apply to healthcare improvement or if they provide an adequate level of support for the complex issues associated with the delivery of safe high quality healthcare.
This has meant that methods/techniques from non-medical fields have been driving the majority of healthcare redesign activities and little new work has been conducted on the development of new techniques or how the existing methodologies being used can be enhanced to provide better support for the quality improvements demanded of Healthcare systems worldwide.

Initial analysis of the methods that have made the transition into the healthcare improvement domain suggest that although many of the techniques cater adequately for operational process improvement, they lack support for: linking processes to the organisational strategy, workflow automation, integrated technology support and communication mechanisms for evaluating improvements. This is compounded in healthcare by further requirements to incorporate patient needs, practice guidelines and high levels of specialist knowledge into the mix.

Further details on the analysis of the predominant process models used in healthcare are discussed in the following section.
2.3 Process Improvement in Healthcare

Healthcare organisations are complex structures whose peak performance is measured in quality of patient care. Each new day requires the integration and coordination of professional, support and administrative staffs, sophisticated clinical and information technology, critical processes and inventories and facility resources (HIMSS 2006, webpage).

As outlined in Section 2.2 process improvement techniques have been used extensively in other domains for many years but it is only in the relatively recent past that the healthcare domain has recognised that process improvements in healthcare may be achieved through the use of similar reengineering approaches. Methods such as Lean Thinking, Six Sigma, Unified Modeling Language (UML) and Business Process Reengineering (BPR) have been used for process reengineering initiatives within the Healthcare domain both in Australia and overseas (Hammer and Champy 1993; Motorola University 1994; Womack and Jones 2003; Health Level 7 2005; iSixSigma Healthcare 2006).

Batalden and Splaine (2002) discussed how continual improvement and innovation within healthcare can be supported into the 21st Century. This work suggests that there are eight knowledge domains that must be present to lead the continual improvement of the quality and value of healthcare. They are:

- Healthcare as a process or system
- Customer/beneficiary knowledge
- Developing new, locally useful knowledge
- Leading, following and making changes in healthcare
- Variation and measurement
- Professional subject matter
- Social context and accountability
- Collaboration

Although this work is not specific to the evaluation of process models it provides key areas of concentration that must be addressed when undertaking healthcare process improvement activities. These knowledge domains provided valuable background to the development of the improvement architecture and related process modeling assessment framework presented in Chapters 4 and 5 respectively.

In addition an increasing number of publications discuss individual healthcare process improvement experiences (Nemeth et al. 1998; Bushell and Shelest 2002; Kerr et al. 2002; Anzbock and Dustdar; ARCHI Net News 2004; Bassham 2005; Bernstein et al. 2005; Bolch 2005; Gospodarevskaya et al. 2005; IHI 2005; Szwarcbord 2005) as a small example. However, relatively few discuss whether the methods employed were adequate or supported the quality improvement exercise well enough.

Works that do discuss barriers and implementation issues are aimed at differing levels of abstraction to this research. For example Sehwail highlights cultural change and correct metric identification as some issues experienced when implementing Six Sigma (Sehwail and DeYong 2003). Mortimer (2002) also discusses issues with organisational culture as well as management problems, misuse of the theory and practice and team creation and cost as general barriers to clinical practice improvement. Horn’s (2001) Clinical Practice Improvement (CPI) method discusses the ‘process of care’ but the use of this terminology in the CPI context refers to treatment processes such as which drugs are dispensed at what dose and rate as an example.

Scale and complexity of change, lack of data availability, conflicting objectives and lack of buy-in are cited by Harper and Pitt (2004) as challenges in healthcare modelling. Laursen (2003) states that ‘using methods from industry’ led to considerable initial resistance from staff. This work also discussed organisational communication complexities and the difficulties in bringing together the ‘right players’ with the appropriate degree of power to implement change as project challenges.
Seila presented seven rules for modelling healthcare processes but these rules were aimed at simulation modelling, not descriptive modelling, the focus of this research (Seila 2005).

Curry et al. (2005) highlighted several areas in which current process modeling techniques failed to provide adequate support for the healthcare domain. These included the inability to explicitly link healthcare strategy to the modeling and design process, poor modeling constructs for the representation of the complex process and information flows involved in clinical pathways, the lack of consistency in the provision of computer-interpretable guidelines for workflow automation and inadequate procedures for the provision of information for decision support system reporting. This work was performed in the early stages of the thesis development and as such provided a foundation for the construct of the research hypotheses.

To understand the current landscape relating to process improvement in the healthcare domain, a review of the drivers for change and the dominant change agents follows. This will include a review of how patient journey modelling is positioned within the healthcare improvement arena.

### 2.3.1 Drivers for Change

In 1995, an Australian study into 14,000 hospital admissions in two Australian States found that up to 16% of patients were killed or injured as a result of their treatment rather than their original medical condition (Wilson et al. 1995). The then Federal Health Minister stated in Parliament that if these figures were extrapolated to a national level, that as many as 230,000 patient could be involved in preventable adverse events with up to 14,000 of these being fatal (Goddard 2003).

#### 2.3.1.1 U.S. Institute of Medicine

Similar findings on a much larger scale were driven home in 1999 with the release of the United States Institute of Medicine (IOM) report ‘To err is human: Building a safer health system’. The report suggested that as many as 98,000 people were dying each year in US hospitals due to medical injuries, that is, injuries incurred during the patient’s hospital stay (Kohn et al. 1999). Although data reported was between 5-8
years old, the media and the public was up in arms over the fact that being sick and receiving poor quality health care could be more damaging to a person’s overall well-being than the original condition for which the patient was being treated. The report reframed ‘Medical Error’ as a chronic threat to public health (Kohn et al. 1999). This report resulted in huge public attention on the crisis in the US health care system and demanded overall improvements to the delivery of U.S. healthcare and in particular significant attention to increased patient safety.

Further work carried out by the IOM produced a second report, ‘Crossing the quality chasm: A new health system for the 21st century’ which was released in 2001 (Committee on Quality of Health Care in America). This report analysed the need for change at four different levels, with level A being the driver for change at all other levels:

a) the experience of patients,
b) the functioning of small units of care delivery (microsystems),
c) the functioning of the organisations that house or otherwise support the Microsystems and
d) the environment of policy, payment, regulation, accreditation and other such factors, which shape the behaviour, interests and opportunities of the organisations at Level c).

These key quality areas set a way forward for the US health system and resulted in the definition of the IOM’s six (6) overarching ‘Aims for Improvement’ as described in Chapter 1 (Committee on Quality of Health Care in America 2001).

As highlighted by Berwick in his ‘User's manual for the IOM's 'Quality Chasm' report’ the IOM committee minced no words in its assessment of the capacity of the current health care system to achieve these six aims when stating: “In its current form, habits, and environment, American health care is incapable of providing the public with the quality health care it expects and deserves” and concluded “that current rates of injury from care are inherent properties of current system designs and that safer care will require new designs” (Berwick 2002, p.83/84).
Berwick further postulated that to achieve the stated aims, the microsystems that provided care could not continue in their current state but would have to be redesigned (Berwick 2002). Such comments when coupled with the ‘Aims for Improvement’ have formed the basis for change programs throughout the US health system and the impetus for healthcare delivery reviews worldwide.

To date most work in health care improvement has primarily dealt with issues concerning the first three points; namely improving patient safety, reducing care variability and making the patient the center of the care process. Natural flow on effects from such work has however also seen good results for the timely, efficient and equitable delivery of healthcare (Bensing 2000; Litvak and Long 2000; Leape et al. 2002; Berwick et al. 2003; Litvak et al. 2005; U.S. Department of Health & Human Services 2005; Australian Commission on Safety and Quality in Health Care 2006; JCAHO 2006; Silow-Carroll et al. 2006).

However, confirming that significant work is still required in these areas, the latest report from the Commonwealth Fund Commission on a High Performance Health System (2006) promotes almost identical core goals and priorities for performance improvement in the U.S. health system, albeit, framed in a slightly different grammar. (See Figure 2.2).

Figure 2.2. ‘Core Goals and Priorities for Performance Improvement’ from a Framework for a High Performance Health System for the United States (The Commonwealth Fund Commission on a High Performance Health System 2006)
The core focus areas for improving healthcare delivery to date are presented in the following sections.

2.3.1.2 Improving Patient Safety and Reduced Care Variability
Despite such significant interest and efforts to increase patient safety, recent studies by the Institute for Healthcare Improvement (IHI) estimate that up to 15 million incidents of medical harm still occur in U.S. hospitals each year (IHI 2006). However continuing research suggests that there is a strong link between patient safety and the degree of variability in the care process. To date significant studies are showing that the more consistent, that is, less variable, the process of care, the higher the levels of patient safety (Bensing 2000; Browne and Warren 2002; Henderson et al. 2004; IHI 2004; Berwick et al. 2006; IHI 2006; Jensen et al. 2006; Mitka 2006).

In 2002, Leape et al. (2002) highlighted the correlation between the delivery of evidence-based medicine and improved patient safety. This work discussed Shojania et al.’s. (2001) report on the evidence of effectiveness of certain treatments in preventing complications. The project’s aim was to collect and critically review the existing evidence on practices relevant to improving patient safety. It found that the main focus to date had been on epidemiology errors and adverse events, rather than on practices that reduced such events. Report results suggested that in terms of strength of evidence, there were 11 practices that had been proven to decrease patient risk and this evidence supported widespread implementation.

Such work has led to significant campaigns to reduce the variability of care delivered, for the purposes of improved patient safety. Two cases in point are the Institute of Healthcare Improvement (IHI) 100,000 lives and 5 million lives campaigns. Launched in December 2004 and December 2006 respectively both of these campaigns are aimed at actively reducing the number of adverse deaths in U.S. hospitals through the introduction of a number of standard evidence-based interventions. The 100,000 lives campaign introduced six such interventions at more than 3000 care sites in the U.S., averting over 122,000 patient deaths over an 18-month period (IHI 2004; Berwick et al. 2006; Mitka 2006).
Continuing on from the 100,000 lives initiative, “the ‘5 Million Lives Campaign’ asks hospitals to improve more rapidly than before the care they provide in order to protect patients from five million incidents of medical harm over a 24-month period, ending December 9, 2008” (IHI 2006). It is proposed that these targets will be met through the introduction of 12 standardised care improvements in the participating hospitals (IHI 2006).

Together these initiatives represent the largest improvement efforts ever undertaken by the health care industry in recent history and indicate that removing process variability for a given patient journey is an important activity that will increase patient safety and assist in improving outcomes.

2.3.1.3 Patient-centered Care

The doctor of the future will give no medicine, but will interest his patients in the care of the human body, in diet, and in the cause and prevention of disease (Edison 1847-1931)

The above quote by Thomas Edison points to empowering the patient to control their own health and well-being, by taking an active interest in how they live their lives, what they eat and how best to take care of themselves holistically. This patient-centered approach is being echoed some 75 years later as the answer to reducing Healthcare costs across the board (Prochaska et al. 2005; Queensland Department of Health 2005).

The IOM’s “Crossing the Quality Chasm” report clearly stated that ‘Patient-centeredness’ was one of its six over-arching Improvement Aims. The report challenged the U.S. Health System to honor the individual patient, respecting the patient’s choices, culture, social context and specific needs. It suggested that this could be achieved via redesign of the microsystems that deliver care, but that the redesign activities would need to adhere to three redesign principles:

1) knowledge-based care,
2) patient-centered care and
3) systems-minded care.
These redesign principles require: the use of the best science and clinical information available in the service of the patient, putting each patient in control of his or her own care and the coordination, integration and efficiency of care across organisational boundaries, disciplines and roles (Berwick 2002).

There are two sides to this approach: 1) Provide readily available information to the public on lifestyle and general health issues and 2) Involving patients in the redesign of the care processes they participate in.

By arming individuals with appropriate information about their immediate healthcare concerns, visits to local GPs can be reduced for low to medium-risk health issues or fast-tracked for confirmed high-risk conditions. Decision Support and Expert Systems are being used to deliver primary care information via telephone Help-Lines, staffed by Healthcare workers, in areas such as sun-cancer prevention, quit-smoking programs, diet improvements and mammogram follow-ups (Prochaska et al. 2005). The USA’s Blue Cross Blue Shield Association actively encourages their members to build relationships with primary healthcare providers and take an active part in their own well-being, thus controlling their personal health care costs and longer term insurance premiums (BlueCross BlueShield Association 2005).

Although still not commonplace, the inclusion of patients in the redesign of care project, can provide valuable insights into the way patients perceive the system and can assist in producing better care processes at a holistic level. Good results from several healthcare process improvement projects can be found in (Nemeth et al. 1998; Bensing 2000; Homer et al. 2001; Bushell and Shelest 2002; Johnson 2002; Coiera 2003; Bate et al. 2004; Bassham 2005; Gospodarevskaya et al. 2005; Szwarcbord 2005; Curry et al. 2006).

A patient-centric approach is also supported by the UK’s National Health Service (NHS), where the final footnote in the NHS Step-by-step guide to developing Integrated Care Pathways is headed ‘How to increase your chances of success’ and makes only one statement: Remember To Keep The Patient At The Centre Of The Process! (National Health Service 2005).
2.3.2 Dominant Change Agents
The two most dominant change agents in the healthcare improvement arena are the U.S. Institute for Healthcare Improvement (IHI) and the UK’s National Health Service (NHS) Institute for Innovation and Improvement (formerly NHS Modernisation Agency). Both of these organisations have implemented significant healthcare improvement programs and initiatives that are driving results not only in their own countries but on the worldwide stage as well.

2.3.2.1 Institute for Healthcare Improvement (IHI)
The Institute for Healthcare Improvement (www.ihi.org) is a not-for-profit organisation leading the improvement of health care throughout the world. Founded in 1991, led by eminent researcher Donald Berwick and based in Cambridge, MA, IHI is a catalyst for change, cultivating innovative concepts for improving patient care and implementing programs for putting those ideas into action. Thousands of health care providers, including many of the finest hospitals in the world, participate in IHI’s groundbreaking work (IHI 2006).

IHI developed the Breakthrough Series to help health care organisations make “breakthrough” improvements in quality while reducing costs. Since 1995, IHI has sponsored over 50 Collaborative projects on several dozen topics involving over 2,000 teams from 1,000 health care organisations. Collaborative teams from the U.S., Canada and Europe have achieved dramatic results, including reducing waiting times by 50 percent, reducing worker absenteeism by 25 percent, reducing ICU costs by 25 percent, and reducing hospitalisations for patients with congestive heart failure by 50 percent (IHI 2003).

An analysis of the major healthcare reviews occurring in Australia indicated that the Breakthrough Series was also a key resource employed in these projects (Curry and McGregor 2005).

The primary enabler of the Breakthrough Series is the Model for Improvement (MFI) as shown in Figure 2.3. The MFI identifies four key elements of successful process improvement:
1) specific and measurable aims, 
2) measures of improvement that are tracked over time, 
3) key changes that will result in the desired improvement, and 
4) a series of testing “cycles”.

Implementation of these elements results in 6 basic stages:

1. “**What are we trying to accomplish?**” relates to Setting Aims. All projects require the team to know what the target improvement goals are. This requires the setting of achievement targets or aims. The aims should be time-specific and measurable; they should also define the specific population of patients that will be affected.
2. “How will we know that a change is an improvement?” is about Establishing Measures. Following implementation, quantitative measures are used to determine if a specific change actually led to an improvement.

3. “What changes can we make that will result in an improvement?” concerns Selecting Changes. All improvement requires making changes, but not all changes result in improvement. Organisations therefore must identify the changes that are most likely to result in improvement.

4. Testing Changes involves the use of ‘Plan-Do-Study-Act cycles (PDSA). The PDSA cycle is shorthand for testing a change in the real work setting on a small scale — by planning it, trying it, observing the results, and acting on what is learned. This is the scientific method used for action-oriented learning.

5. Following testing, comes Implementing Changes. After testing a change on a small scale, learning from each test, and refining the change through several PDSA cycles, the team can implement the change on a broader scale — for example, for an entire pilot population or on an entire unit.

6. Spreading Changes then occurs. After successful implementation of a change or package of changes for a pilot population or an entire unit, the team can spread the changes to other parts of the organisation or to other organisations.

(IHI 2003)

Lacking from the Breakthrough Series methodology is any form of healthcare specific modeling representation of the patient journey/s under review. The majority of documentation is in textual format and any graphical notations are at the discretion of the redesign team. Standard flowcharts and Lean value stream maps are discussed although they do not form a core component of the method. Integration of strategic objectives, patient input and organisational structure into the definition of the patient journey is also variable.
2.3.2.2 National Health Service (NHS)

The UK’s National Health Service (NHS) Institute for Innovation and Improvement (formerly the Modernisation Agency) is recognised as a leader in healthcare quality improvement and has conducted major process reengineering projects over several years. As an individual organisation, the NHS modernisation programme is the largest and most systematic quality improvement effort anywhere in the world (NHS Modernisation Agency 2005).

The NHS began their first attempt at patient-focused process improvement in the early 1990’s. This project was instigated after a visit to the U.S. to learn about the ‘Anticipated Recovery Pathways’ program. The resulting NHS Integrated Care Pathway (ICP) initiative was clinician led and driven and had patients and locally agreed, best practice at its’ core (National Health Service 2005).

In 1997 the UK Department of Health released a white paper entitled ‘The New NHS- Modern, Dependable’. This initiative was designed to reinvigorate the NHS and move it to a model of integrated care that “combined efficiency and quality with a belief in fairness and partnership”. The significance of this program was highlighted with the allocation of £1.5 billion in the first two years of operation and the instigation of a strategic Healthcare Improvement Program (UK Department of Health 1997).

Just three years later another new initiative, ‘The NHS Plan’ was launched by the UK Department of Health. The report stated that despite many achievements, the NHS had failed to keep pace with changes in society and outlined a vision of a health service designed around the patient (UK Department of Health 2000). Two significant bodies were established as part of ‘The Plan’: The National Primary Care Collaborative and the Modernisation Agency.

The NHS National Primary Care Collaborative launched in 2000 was originally described as the world's largest health care improvement project. It now encompasses nearly 2,000 practices nationwide covering almost 11.5 million patients. To date the Collaborative has helped to reduce by an average of 60% the waiting time for an appointment with a general practitioner (IHI 2003).
The NHS Modernisation Agency was established in April 2001. This Agency was designed to support the NHS and its partner organisations in the task of modernising services and improving experiences and outcomes for patients. Since 2001 over 150,000 NHS staff have been engaged in redesigning healthcare projects via the NHS Modernisation Agency (NHS Modernisation Agency 2005).

The Modernisation Agency was superceded on 1st July 2005 by the NHS Institute for Innovation and Improvement. The Institute heralds a new era of improvement and change for the NHS. Established as a Special Health Authority, and based on the campus of the University of Warwick, the mission of The Institute is to support the NHS and its workforce in accelerating the delivery of world-class healthcare for patients and the public by encouraging innovation and developing capability at the frontline. As an ‘arms-length-body’ of the NHS, The Institute (as a single entity) operates with an annual budget of £80 million (NHS Modernisation Agency 2005).

The NHS Institute main aims are to:

- work closely with clinicians, NHS organisations, patients, the public, academia and industry in the UK and world-wide to identify best practice
- develop the NHS’ capability for service transformation, technology and product innovation, leadership development and learning
- support the rapid adoption and spread of new ideas by providing guidance on practical change ideas and ways to facilitate local, safe implementation
- promote a culture of innovation and life long learning for all NHS staff (NHS Modernisation Agency 2005).

In support of these aims The Institute has developed extensive material concerning improvement methods, techniques and clinical standards. A key category is available for ‘Improvement Leaders’ on patient journey redesign and outlines what steps should be followed during such collaborative sessions. The redesign methodology discussed is largely based on the IHI Breakthrough Series method (NHS Modernisation Agency 2005; NHS Modernisation Agency 2005).
Process models are suggested as part of the ‘Improvement Leaders Guides’, with flowcharting and Lean Thinking Models supported. Initially much of the design work utilises ‘post-it’ notes stuck on butchers paper or a whiteboard. Formal patient journey process models are only constructed after agreement by all session participants on the ‘post-it’ note flow. Although this system appears archaic, results reported by the NHS indicate that this system has delivered better access to A&E treatment, major reductions in both inpatient and outpatient waiting times, and significantly improved services in cancer, coronary heart disease and radiology (NHS Modernisation Agency 2005).
2.3.3 Patient Journey Modeling

One aspect that is critical to overall healthcare improvement is Patient Journey Modeling (PJM) and as the thesis title suggests PJM is the core focus of this research activity.

PJM is a patient-centric activity that details a patient’s interaction with and progress through a healthcare system for a given service (NHS Modernisation Agency 2005; NHS Modernisation Agency 2005) and deals primarily with modeling the manner in which healthcare is delivered, that is ‘the system of care’. It involves analysis of each aspect of clinical care delivery including the multiple processes required to deliver the care for a given task. Models based on these principles provide a framework to reduce the variability of care by helping to understand the relative significance of any one or related group of variables contributing to patient outcomes. Models also assist in building consensus among healthcare workers, as well as in the planning of interventions and improvements (Camann 2001).

One of the goals of PJM is to improve patient safety and health care quality by reducing variability in the care process. This involves the analysis of the overall processes involved with the movement of a patient through a healthcare system, and then analysing how this journey can be improved via the removal of unproductive, duplicated and excessive activities and improved communications between the patient, their carers and the clinicians involved with the journey itself (IHI 2003; Curry and McGregor 2005; NHS Modernisation Agency 2005; NHS Modernisation Agency 2005).

Several terms are used in the literature to refer to the concept of patient journey modeling (PJM) including: clinical pathways improvement, optimising patient flow, clinical practice improvement and redesigning healthcare (Horn 2001; NSW Department of Health 2002; IHI 2003; Haraden and Resar 2004; Szwarcbord 2005; UK Department of Health 2005; Jensen et al. 2006).

This research uses the term ‘patient journey’ to include not only the flow or implementation of improved clinical practice but to encompass the complete spectrum of a patient’s experience for a given service.
PJM falls into the domain of “Medical/Health informatics (MI/HI) which is an evolving scientific discipline that deals with the collection, storage, retrieval, communication and optimal use of health related data, information and knowledge. The discipline utilises the methods and technologies of the information, social and technology sciences for the purposes of problem solving and decision-making thus assuring quality healthcare in all basic and applied areas of medical, biomedical and health science” (Shortliffe et al. 2001; International Medical Informatics Association 2006)

The concepts of Patient Journey Modeling have been used to redesign patient-centric healthcare processes for almost 15 years. The Institute of Healthcare Improvement (USA) and NHS Institute for Innovation and Improvement (UK) have used various forms of this approach since the 1990’s (IHI 2003; UK Department of Health 2005).

Programs that have included patient journey modeling have achieved dramatic results in traditional hospital settings, including reducing waiting times by 50 percent, reducing worker absenteeism by 25 percent, reducing ICU costs by 25 percent, and reducing hospitalisations for patients with congestive heart failure by 50 percent (IHI 2003). Key publications discussing this issue under the banner of ‘patient flow’ include Haraden and Resar (2004), Brideau (2004), Henderson et al. (2004), IHI (2003), JCAHO (2004; 2005) and Jensen et al. (2006).

Australia has also conducted several such projects with similar leaps in improvement. An example in case is the Flinders Medical Centre in South Australia which has introduced improved processes in the Emergency Department (ED). These improvements now see 90% of (non-admittance) patients attending the ED, being seen, treated and out within 4 hours (Szwarcbord 2005).

Notwithstanding these achievements, PJM is still not considered a core component of many healthcare improvement (HCI) initiatives.
The reasons for this may be many including the inability of current process modeling techniques to capture all of the nuances and complexities of healthcare environments; the lack of understanding, by healthcare workers, of process modeling and the benefits it can deliver; and the lack of a healthcare specific PJM approach.

The lack of a healthcare specific PJM approach is evidenced in the following four sub-sections which describe the predominant PJM approaches currently used in healthcare:

- **Lean Thinking**;
- **Process Maps (flowcharts)** as used in Six Sigma;
- **ARIS**; and
- **Unified Modeling Language (UML)**.

### 2.3.3.1 Lean Thinking

A process modeling approach that is receiving increased interest in the healthcare domain is *Lean Thinking* and *value stream maps*. This is primarily due to the fact that *Lean Thinking* is a supported modeling technique for the Institute for Healthcare Improvement and the NHS (IHI 2005; NHS Modernisation Agency 2005).

The principles of *Lean Thinking Management* have been used successfully in the car manufacturing industry, starting with Henry Ford, since the early 1900's. After WWII the techniques were polarised by Toyota in the form of the ‘Toyota Production System’ which continues to this day (Womack and Jones 2003). The *Lean* philosophy, techniques and tools became the focus of landmark books: ‘The Machine that Changed the World’ (1990) and ‘Lean Thinking’ (2003) by Womack *et al* following in-depth studies of the Japanese car manufacturing industry by American researchers in the International Motor Vehicle Program (IMVP) at Massachusetts Institute of Technology. These books exposed other industries to the possibilities of improving production ‘flow’ through the removal of non-value-adding activities. Removal of this production ‘fat’ leads to a ‘lean’ enterprise and will result in more being done with less.
The Lean Thinking method has been used to improve processes in aeronautics, software engineering, the military and healthcare (Bushell and Shelest 2002; Womack and Jones 2003; LAI 2004; Sloane et al. 2006).

Every organisation is made up of a series of processes, or sets of actions, the purpose of which is to create value for the customer. The core principles of the technique involve defining the value each step in a process adds to the end product or service. Any step that does not add value as defined by the customer, is considered a ‘waste’ (muda) and is eliminated from the process flow, thus leaving only those steps that create value in the production of the end product/service (Womack and Jones 2003).

This approach is seen as valid to healthcare improvement as it allows the provider to evaluate process flows (value streams in ‘lean’ speak) in relation to the value placed on particular steps in a process as specified by the patient (customer). Steps that do not add value then become a target for elimination and improved flow. Such an approach in healthcare can lead to increased patient satisfaction, improved productivity and outcome quality and reduced costs (IHI 2005).

In 2006 the native Lean Thinking Value Steam Mapping software was enhanced to provide a limited number of healthcare specific icon libraries. These allow some distinction between patient types, process activities and staff roles. Apart from these enhancements the basic modeling method remain unchanged (GumshoeKI Inc 2006).

Lean Thinking’s value stream mapping technique has been used to model healthcare processes in several countries with varying degrees of success (Bushell and Shelest 2002; Heyamoto 2002; Bassham 2005; Bolch 2005; IHI 2005). NB: As these projects were prior to 2006 they used the native Lean Thinking models with no healthcare specific icon library enhancements.
**Value Stream Maps**

The key development steps in the Lean Thinking approach are (Womack and Jones 2003):

1. Specify the value by specific product;
2. Identify the value stream for each product;
3. Make the value flow without interruption;
4. Let the customer ‘pull’ value from the producer;
5. Pursue perfection.

Initially the scope of the value stream mapping (VSM) activity is defined. This should involve only one particular product family or service. Once the scope is agreed a VSM of the information and materials flow as it stands today (*current state*) is created. Problem areas (known as *kaizens*) are then highlighted and potential improvements evaluated. This leads to the development of the future state value stream map of how the process flow should look after the resulting work plan is implemented (Rother and Shook 2003). The initial steps involved in the value stream mapping process are shown in Figure 2.4.

![Figure 2.4. The Initial Value Stream Mapping Steps](Rother and Shook 2003)
Only value-added and non-value-added cycle times are recorded on the process model. All other measurements are recorded in a separate artifact, ‘a current state box score’. Womack and Jones (2003) suggest 7 key metrics: total lead time, value creating time, changeover time, uptime, scrap/rework, inventory and every part made every; although others can be added based on model development needs. Following implementation of the work plan a future state box score should be produced so that process change improvements can be validated and verified.

In relation to patient journeys, Step 2 in the Lean Thinking method is where the first patient journey model is produced. It describes the existing process activities required to deliver the patient service under review.

This results in a current patient journey value stream map. Step 3 identifies the areas of waste (muda) or non-value-adding activities and prioritises those that will even the flow most significantly. A future patient journey value stream map is produced showing the new and improved patient and process flow.

In relation to healthcare patient journey modeling this technique graphically depicts the movement of an object, in this case a patient, through a selected workflow and highlights duplication and wastage. However this technique takes time to understand and lacks the ability to include/overlay relevant policies/guidelines, patient needs, staff roles and IS system usage as an integral part of the patient’s journey through the Health Care Organisation (HCO). Value stream mapping provides a measurement construct for actual and elapsed process time and process defects. However deficiencies exist in relation to a supplementary and thorough technique for richer model representations that combine strategic objectives, patient input, organisational structure and consistent measurement and evaluation frameworks specifically geared to healthcare process improvement.

A case in point regarding the lack of understanding of healthcare workers of such process modeling techniques and how they are applied can in fact be found in the IHI’s own literature. The IHI’s Model for Improvement (MFI) details the stages involved in a healthcare improvement project but does not discuss the use of lean thinking process models within any of these stages (IHI 2003).
Correspondingly the IHI report on ‘Going Lean in Health Care’ details the benefits and approach of using Lean in health care but does not ever correlate the use of the technique to the MFI (IHI 2005). ‘Work flow’ is discussed in MFI ‘Stage 3 – Changes’ but related links point to flowcharting tools not Lean tools. This leads to an increased confusion for healthcare improvement teams.

In fact patient journey modeling crosses several of the MFI stages as shown in Figure 2.5. In the first stage ‘What are we trying to accomplish?’ the overall aims of the patient journey modeling exercise need to be analysed and agreed. This will include setting the scope of the patient journey and identification of the target patient population affected.

The second stage, ‘How will we know that a change is an improvement?’, is primarily about determining what items will be evaluated and measured as part of the selected patient journey. This will involve gathering current data and existing measurements and then setting target measurements for evaluation of changes post-implementation.
In the third stage, ‘What changes can we make that will result in improvement?’, changes that need to be made to improve the current situation are identified. It is at this point that the MFI mentions eliminating waste, improving ‘workflow’ processes, error proofing, variation and changes to work environment. As mentioned earlier these are the primary areas of concern in patient journey modeling and it is at this point that the visual representation of the patient’s journey in the form of a model should be produced. This will involve modeling the current journey, identifying problem areas, suggesting and analysing potential changes and then deciding which changes will made, by who and when.

A future patient journey model should then be developed (using the same process modeling technique) showing how the improved journey will operate. Process models in the form of flowcharts are discussed in this stage on the IHI website but are ‘buried’ four levels down from the MFI entry point. There is no mention of Lean Thinking process models in this hierarchy at all.

Once the current and future patient journey models are developed and the change priority confirmed, changes can begin to be implemented on a ‘pilot’ basis. This is the goal of the Plan-Do-Study-Act (PDSA) cycles. Output from the PDSA cycles are fed back into the preceding stage to determine the effectiveness of the changes made and to evaluate if the changes have met the measurement targets previously set. If changes are found to have the desired improvement results they are gradually implemented on a wider scale. If anomalies are still present, the redesign team reviews the patient journey models for further improvement opportunities.

\[\text{2.3.3.2 Six Sigma}\]

Six Sigma has been used in healthcare improvement projects to varying degrees and uses Process Maps in the form of Flowcharts to model the patient journey (Sehwail and DeYong 2003; IHI 2004; iSix Sigma Healthcare 2005). Six Sigma is a method for improving productivity and profitability and uses the disciplined application of statistical problem-solving tools to identify and quantify waste and indicate steps for improvement (Motorola University 1994).
Sigma (the Greek letter $\sigma$) is used in statistics to denote the *standard deviation*, a statistical measure of variation.

True Six Sigma demands no more than 6 standard deviations from the mean or not more than 3.4 defects per million parts produced (Motorola University 1994; Keller 2005; Brue and Howes 2006).

Originally used for improving manufacturing processes, Six Sigma is now used in a wide variety of areas including services provision, business processing and healthcare (Sehwail and DeYong 2003; Brue 2005; iSixSigma Healthcare 2006).

The first significant Six Sigma initiative was implemented by Motorola in the 1980’s with Motorola claiming to have generated savings of $15 billion during the first 10 years of use. Other success stories include GE, Allied Signal, DuPont and Mount Carmel Health System, with savings of $12 billion, $1.4 billion, $1.6 billion and $35.8 million respectively (Brussee 2005; Brue and Howes 2006).

The Six Sigma methodology uses a specific problem-solving approach supported by selected Six Sigma tools, to improve processes and production. The methodology is data-driven and customer focused with the main goal being to reduce unacceptable products or events. Strong emphasis is given to the use of statistics as tools for interpreting and clarifying data with focus primarily on improving measurable financial results. Other target areas include improvements to customers, employees and process quality (Brussee 2005; Brue and Howes 2006).

Some projects actually combine Six Sigma with Lean Management to leverage the benefits of both techniques. Examples of combining these techniques can be found in both books and electronic source (George 2003; iSixSigma Healthcare 2006).
DMAIC is the problem solving methodology used in Six Sigma. The methodology generally consists of five phases (iSix Sigma Healthcare 2005).

**Define** the problem, along with the project scope, goals and expected deliverables.

**Measure** the ‘as-is’ process, through development of detailed process-level maps and cost, quality and schedule metrics.

**Analyse** the current process flow and metrics to determine sources of variation and non-value added activities. Determine possible solutions.

**Improve** the ‘as-is’ situation by eliminating identified defects and implementing new process flows.

**Control** involves standardising implemented changes and monitoring the actual impact of the improvements against expectations.

High level processes are outlined in the **Define** phase and can take the form of a **SIPOC** diagram. **Process Maps or Flowcharts** are used in the **Measure, Analyse** and **Improve** phases to construct a detailed picture of the ‘as-is’ and ‘improved’ process flows respectively.

Even though Six Sigma in its entirety is a complex improvement method, the patient journey models produced using process maps are very basic and as such are unable to capture the complexities associated with the processes, people and systems involved in healthcare improvement. In fact the notation set does not contain a symbol to represent a person, be it a patient or healthcare worker or the information involved in their interactions. It is also not possible to explicitly relate process measurements to a process on the model. All measurements are calculated using a separate tool that has no symbolic relationship to a process on the model.

### 2.3.3.3 ARIS

The ARIS Business Process Modeling Toolset was first published in 1994 by Prof. August-Wilhelm Scheer (Scheer 1994). Reportedly servicing over 6,000 customers in over 70 countries, ARIS is considered a leader in the business process modeling domain (IDS Scheer 2004).
ARIS presents a method for analysing processes and takes a holistic view of process design, management, workflow and application processes. The framework is presented as the ‘ARIS House’ and is a concept for describing business processes at three main levels: Enterprise, Business Process and Information Systems (Scheer 1998). ARIS provides modeling methods for a number of different views that when combined form a complete picture of the required information system. Modeling is supported by the ARIS Toolset software system (Scheer 1994).

The ARIS House

In a bid to reduce the complexity of the relationships amongst the classes in the business process model, as they exist at differing levels of abstraction, Scheer groups classes with similar semantic relationships into ARIS views. The introduction of the ARIS House views aid in structuring and streamlining business process models and reducing redundancy (see Figure 2.6).

Figure 2.6 The ARIS House Views (Scheer 1998)
The views represented in the ARIS house are:

**Function:** Models the processes that transform input into output. Also details goals as they are related to and supported by each function. (ARIS uses the term *function* synonymously with process, activity and task.)

**Organisation:** Models the hierarchical organisation structure including responsibilities for particular functions or resources.

**Data:** Details the data processing environment as well as the messages that trigger functions. Also includes environmental data associated with business process enactment.

**Output:** Contains all physical and non-physical input and output.

**Control:** Models the relationships among the other views as well as the entire business process. Acts as an inspection point for view relationship and process description validity.

The *function*, *organisation*, *data* and *output* views, describe the system structure.

The *control view* shows the structural coherences of all the views and the *dynamic behavior of the business process flow* (Scheer 1998).

**ARIS Development Phases**

Under the ARIS House architecture, development of information systems follows a phased approach as shown in Figure 2.7. Business Strategy analysis is initially conducted and then requirements for each ARIS *view* are defined. It is during the *Requirements Definition* phase that *Business Process Models* are developed.
In 2004, Scheer’s company (IDS Scheer) released the ARIS Healthcare Solution and marketed this product as a “tool customised to the specific requirements of the healthcare sector. It enables a clear graphic presentation, analysis and optimisation of complex treatment processes and interactions both within and across hospital boundaries” (IDS Scheer 2004, p.1).

Based on the company’s original business process modeling method and architecture, the main changes are to the ARIS software tool used to build the process models. The major reported enhancement is the inclusion of a “healthcare specific user interface with descriptive symbols” such as a person in a wheelchair. Higher level abstractions of treatment paths are also possible using Diagnosis-Related Group (DRG) costings. Although stated as an industry-specific process modeling solution, the ARIS Healthcare Solution is still based primarily on modeling ‘business’ processes. In addition the toolset is only available in German, with no release date for an English version. There has also been limited use of the toolset in ‘realtime’ hospital settings, with details of only one project at Marienhospital Herne available from the vendor (IDS Scheer 2005).
Green and Rosemann (2000) evaluated the ARIS process modeling method using the Bunge-Wand-Weber representation model. This representation model provides an ontology that can be applied to the evaluation of the grammar used to develop information system models. The ARIS evaluation concluded that the use of the process view alone is not sufficient to model all the real-world constructs required. This suggests that in the complex arena of healthcare improvement, additional views are needed to adequately represent the entire problem domain.

2.3.3.4 Unified Modeling Language

Unified Modeling Language (UML) is the notation used to develop object-oriented artifacts including diagrams and textual specifications. UML is not a method itself but provides a variety of models and diagrams to support any type of object-oriented development methodology (Beeler et al. 1999; Health Level 7 2003; Object Management Group 2006).

Numerous object-oriented (OO) approaches abounded in the early 1990’s and it was during this period that Rational Software began attempts to bring the most popular of these approaches together. By 1995 Rational had employed three leading OO developers: Jim Rumbaugh, Grady Booch and Ivor Jacobson and this team began to look at ways to unite their complimentary approaches. The Unified Modeling Language (UML) we know today evolved from this work with the draft specification for version 1.0 proposed to the Object Management Group (OMG) in 1997 (Object Management Group 1997). The latest version, UML 2.0 was formalised in 2005 (Object Management Group 2005).

The key benefits of the UML approach relate to the fact that the language and its tools (diagrams) can be used throughout the systems development process from gathering systems requirements to implementation of the final system. As a general purpose modeling language UML bridges the communication gaps that often exist between analysts, designers and developers (Unhelkar 2005). UML can be used to model a myriad of system types including software systems, hardware systems and real-world organisations.
UML’s main contribution to the healthcare domain is its use in the development of the Health Level 7 (HL7) Reference Information Model (RIM). The RIM model is part of “a comprehensive framework and related standards for the exchange, integration, sharing and retrieval of electronic health information that supports clinical practice and the management, delivery and evaluation of health services” (Health Level 7 2005). The HL7 suite of standards is developed by Health Level Seven Inc in collaboration with a wide variety of HL7 ‘member’ institutions. Health Level Seven Inc is a Standards Developing Organisation that is accredited by the American National Standards Institute. Founded in 1987 to produce a standard for hospital information systems, HL7 is currently the predominate standard for the interfacing of clinical data in most institutions (Health Level 7 2005).

Major projects using HL7 standards to support Electronic Health Records (EHR) and clinical data exchange are underway in the U.S., UK, the Netherlands, Canada, Germany and Croatia (Health Level 7 2005).

A major issue with HL7 in relation to this research is the fact that the RIM deals mainly with modeling of the data required to pass information between information systems (Health Level 7 2005). Modeling of the processes involved is only conducted for the purposes of capturing the data a process needs to communicate with other processes.

Therefore if process modeling for descriptive purposes is required, another HL7 compatible (that is, UML based) modeling tool needs to be used. Use of such a UML-based model allows for relatively seamless translation from analysis-to-design-to-system specification and implementation in HL7 compliant environments.

A HL7 compatible tool that is appropriate is UML’s Business Process Modeling Notation (BPMN). BPMN addresses the issue of modeling real-world organisations and was developed by the Business Process Management Initiative (BPMI) Domain Task Force (Object Management Group 2006). This work focuses on all aspects of business process management and has been adopted as an official Object Management Group (OMG) specification (2006).
The primary goal of _BPMN_ is to provide a notation that is readily understood by the complete range of stakeholders involved in business system development. Many users refer to this technique as the ‘swimlane’ model. In addition the notation ensures “that XML languages designed for the execution of business processes, such as BPEL4WS (Business Process Execution Language for Web Services), can be visualised with a business-oriented notation” (Object Management Group 2006). OMG states that this approach represents the amalgamation of best practices within the business process modeling community (Object Management Group 2006).

BPMN however fails to accommodate the provider strategy, patient needs or decision support system requirements. In addition the models are not patient-centric and do not clearly identify care handovers. The ability to define a role type and skill level or organisational responsibility for resources is also absent.

NB: A full and detailed description of the modeling notation and semantics used by these methods/techniques along with a case study example of the models ‘in action’ will be presented in Chapter 5 as part of the assessment of these methods/techniques and their degree of support for modeling process improvement within the healthcare domain.

### 2.3.4 Conclusions and Implications for Patient Journey Modeling Research

Much of the recent research into improving healthcare has centered on reducing variability, improving patient safety and enabling change through the use of technology. These concentrations are a direct result of the Institute of Medicine (IOM) two keystone reports into the American healthcare system; “To Err is Human: Building a Safer Health System” and “Crossing the Quality Chasm” and the UK’s NHS healthcare crisis.

Leadership in healthcare quality improvement is currently being provided by the Institute for Healthcare Improvement and England’s NHS, although many papers can be found on individual process improvement initiatives worldwide. Although process modeling is acknowledged as an important aspect of healthcare improvement, all of the methods and techniques adopted to date have been taken from other fields such as manufacturing, management and computing. However
very few publications question the validity of this situation and none of these works actually formally evaluate the level of support afforded to healthcare process improvement by these methods (Young et al. 2004; Ben-Tovim 2005; IHI 2005; NHS Modernisation Agency 2005).

At a generic level Ivari et al (2001) proposed a comprehensive framework for classifying IS methodologies and approaches but this work does not assess the effectiveness of the modeling techniques that a method or approach may employ.

To date the Healthcare domain lacks a design and modeling methodology and associated tools adequately tailored to support the specific requirements involved with redesigning the patient journey from a patient-centric perspective. A reason for this was eluded to in a recent publication by Jensen et al. (2006) when they suggested that “a complex concept such as patient flow in healthcare must always involve elements of seeming incongruity that ultimately come together as a meaningful whole” (p.1). They went on to state that improving patient flow involved looking at the problem from a series of different perspectives or ‘lenses’ and that such an approach permitted a more acute view of the problem that was applicable to any initiative designed to improve flow. This supports the multi-dimensional approach for patient journey modeling as presented in Chapter 4 and relates to research hypotheses 1 and 2 from Chapter 1.

The dominant change agents within the healthcare domain, the IHI and NHS, promote the use of the Model for Improvement for healthcare redesign but this method lacks a robust healthcare specific modeling technique for capturing the multiple dimensions associated with delivering safe, high quality patient journeys. Although the IHI and NHS suggest using Lean Thinking and flowcharts to analyse work flow, these techniques are not a core component of the overall improvement approaches in either organisation’s literature.

Apart from Lean Thinking and flowcharts, other process modeling techniques are also used to varying degrees within the domain including ARIS and UML. However none of these methods cover ALL of the critical areas such as the capture of organisational goals, the socio/economic and cultural needs of patients, information
systems requirements or support for automated workflows and ongoing decision support. In addition none of the methods are patient centric or identify discontinuities of care or patient handovers or explicitly link evidence-based best practice to processes on the model. The ability to define the role type and skill level required to deliver a particular clinical treatment and who is responsible for a given physical resource is also lacking.

Although many works dealing with healthcare improvement and process modelling have been published, all with the exception of Curry et al. (2005), discuss either individual project implementations or problems with improvement at a higher level of abstraction to this research. They do not discuss the level of support provided by the process modelling techniques employed.

When comparing process reliability and the need for improvement, with other industries, Resar claims that health care clinicians successfully apply proven medical evidence less than 80% of the time. Such a “low level of reliability at the basic process level means that health care’s efforts to improve reliability start from a different baseline (to other industries), and therefore may require a different approach” (Resar 2006, p.1678). He suggests that part of this difference may be due to the fact that healthcare settings vary from other types of industries in four key areas:

a) extreme dependence on hard work and personal vigilance;

b) a focus on mediocre benchmark outcomes rather than process;

c) great tolerance of provider autonomy; and

d) a failure to create systems that are specifically designed to reach articulated reliability goals (Resar 2006).

When combined with the deficiencies outlined above this confirms that open research questions still exist concerning the appropriateness of applying non-healthcare specific process modeling techniques to healthcare process improvement projects.
In addition many initiatives to date have focused on improving the way patients move through the Emergency Department (ED) as this is the public-face that the community interacts with in times of crisis. But attempts to improve patient flow that focus only on the ED miss the larger picture: effective patient flow is a property of the entire system and can only be optimised at the system level (IHI 2007). This suggests that any new work must not only consider clinical improvements or flow but must take a holistic view of the entire healthcare continuum including the people patients interact with, information created/transformed and improvement measurement criteria as an example.

Due to the huge worldwide interest in improving healthcare delivery and therefore the fundamental processes enacted in the provision of high quality care, accurate and comprehensive modelling of the patient’s journey is of critical importance. This suggests that focussed attention needs to be given to the development of a domain specific improvement architecture, that is, a patient journey modelling meta-methodology that can be used to:

1. Assess the levels of support provided by current modelling tools and techniques and
2. Develop new multi-dimensional healthcare specific patient journey modeling tools and techniques.

Development of such a construct presents a solution to research hypotheses 1, 2 and 3.
2.4 Healthcare Strategy

Strategy is defined as “a detailed plan for achieving success in situations such as war, politics, business, industry or sport” (Cambridge University Press 2006). The strategy of an organisation is derived from the Vision and or Mission statements as defined by the Board or Executive Committee. To ensure that healthcare redesign activities have a solid direction and purpose, the strategy of the healthcare provider must be documented and well understood by management and the redesign team. A key strategic management system widely used in many domains including health is the Balanced Scorecard.


2.4.1 Strategy Analysis

The strategy of a Healthcare Organisation (HCO) will determine the overall direction the organisation’s leadership has set, including services to be offered, quality of care targets, human resources policy and financial objectives.

Healthcare strategy setting and performance measurement has seen increased interest in the last 10 years. This has resulted from key reports into improving the quality of healthcare and patient safety such as “To Err is Human: Building a Safer Health System” (Kohn et al. 1999) and “Crossing the Quality Chasm” (Committee on Quality of Health Care in America 2001). The UK’s National Health Service (NHS) Institute for Innovation and Improvement program is also strongly grounded in the development of a sound strategy, as demonstrated in the “NHS Plan: a plan for investment, a plan for reform” (UK Department of Health 2000). Many countries have also developed measurement frameworks or toolkits to guide standardised measurement within their organisations (Ontario Hospital Association 1999; Australian Commission on Safety and Quality in Health Care 2006; JCAHO 2006).

Inamdar and Kaplan (2002) suggest that HCOs driven by a strategy of improving consumerism demonstrate the greatest performance improvements.
This research proposes the use of a Balanced Scorecard approach to Healthcare Strategy implementation as part of the patient journey modeling initiative.

### 2.4.2 Balanced Scorecards

The Balanced Scorecard is (BSC) is an instrument that translates the mission and strategy of an organisation into a broad collection of action metrics and indicators that subsequently provide the structure necessary to serve as a control and strategic measurement system (Kaplan and Norton 1992; Kaplan and Norton 1996).

Robert Kaplan and David Norton developed the Balanced Scorecard in the early 1990s. It arose from extensive research work conducted with 12 leading edge performance measurement companies in the United States. The study concluded that financial measures alone are insufficient for managing complex and ever-changing business environments, especially as organisations become more customer-driven and look to leverage their intellectual capital and knowledge-based assets (Kaplan and Norton 1992).

Kaplan and Norton’s work found that:

*executives understand that traditional financial measures alone, such as return-on-investment and earnings-per-share can give misleading signals for continuous improvement and innovation (1992).*

Their work demonstrates that financial measures are not the only area that managers should consider when assessing the ‘health’ of the business. The major outcome of the original year-long project was the proposal that an organisation’s mission and strategy should be translated into strategic objectives with four (4) broad categories of measurement focus namely: *Customer Perspective, Internal Business Perspective, Innovation and Learning Perspective and Financial Perspective*. Inclusion of these perspectives provide a balance between short and long-term objectives, financial and non-financial measures and external and internal performance indicators (Inamdar and Kaplan 2002). Figure 2.8 presents Kaplan and Norton’s original BSC perspectives.
Customer Perspective
The central question in this perspective: “How do our customers see us?”, looks at how the organisation is performing from the viewpoint of the customer. Customers are most concerned with time, quality, performance and service and cost. The understanding of what constitutes ‘value’ in these areas for the organisations specific target customers is the primary focus. To put the BSC into practice for this perspective, organisations should define objectives for time, quality, performance and service and cost and then translate these objectives into specific measures at the operational level (Kaplan and Norton 1992).

Internal Business Perspective
Definition of the Customer Perspective points to what internal processes the business must excel at to meet the set objectives. Managers must concentrate on the critical internal operations that will enable them to satisfy customer needs. Organisations should decide what processes and operations they must excel at and specify measures for each (Kaplan and Norton 1992).
Innovation and Learning Perspective

Unfortunately customers needs and business environments are not stagnant and therefore organisations must continually improve current products and look to introduce new and innovative products and services just in time for market requirements. Objectives here are set around working smarter with not only existing technology and staff but also efficient adoption of new technology and training (Kaplan and Norton 1992). This perspective defines the core competencies and skills, the technologies and the corporate culture required to support the overall strategy. These objectives enable an organisation to align its human and IT resources with its strategy (Kaplan and Norton 2000).

Financial Perspective

“How do our shareholders/stakeholders see us?” is the key question in this perspective and typically involves financial goals for profitability, growth and shareholder value. Measures here indicate if the organisation’s strategy implementation is contributing and improving the bottom-line (Kaplan and Norton 1992). In cost containment environments such as public healthcare, stakeholders include the Federal and State governments as well as Local Area Health Services, patients and health care workers and these are at the forefront of objective setting in this perspective.

Fiscal benefits from improved business processes are typically realised in stages. Short-term benefits are created from cost savings in increased operational efficiencies and process improvements. Revenue growth or cost containment from improved customer relationships accrues in the medium-term. Long-term fiscal improvements result from increased innovation and use of new technologies and systems.
2.4.3 Balanced Scorecards in Healthcare

Several researchers have suggested that the Balanced Scorecard strategic planning methodology and performance measurement framework can be directly and successfully applied to the healthcare sector. Results include improved market position, financial results and customer satisfaction (Forgione 1997; Voelker et al. 2001; Inamdar and Kaplan 2002; Urrutia and Eriksen 2005).

In 1997 a forum involving prominent researchers from Australia, Belgium, Canada, Finland, France, Germany, Hungary, Italy, Japan, The Netherlands, Norway, Poland, Spain, Sweden, the United Kingdom, and the United States resulted in an International call for the use of "balanced-scorecard" reporting by health care providers. This was to include 'both financial and quality performance measures-both for internal use and for external disclosures to the purchasing public' (Forgione 1997).

Evidence of the adoption of the Balanced Scorecard within the healthcare sector is found in write-ups of implementation experiences of several prominent healthcare organisations such the Mayo Clinic, Duke University Medical Centre, John Hopkin’s hospital, the Henry Ford Health System, the Burn Center of the University of Colorado Health Sciences Center and the U.S. Army Medical Department (Wachtel et al. 1999; Curtright et al. 2000; Holt 2001; Meliones 2001; Voelker et al. 2001).

Performance measurement became commonplace in healthcare in the 1990s. In the U.S., the Joint Commission on Accreditation of Healthcare Organisations (JCAHO) accredits over 18,000 healthcare organisations through the use of performance measures (JCAHO 2006; JCAHO 2006). In a project conducted by Inmadar and Kaplan (2002) involving nine American healthcare organisations they found that healthcare executives viewed BSC as being advantageous over other performance measurement systems due to the fact that it:
• Did not focus on narrow regulatory, clinical or diagnostic operations.
• Offered better timeliness and forward-looking indicators.
• Captured the complexity and interrelationships of strategy and operational alignment including tradeoffs among quality and costs.
• Complemented existing measurement systems by guiding process improvement at the operational level.

More recently Health Care Organisations (HCOs) have been adapting Kaplan and Norton’s initial four perspectives to more clearly define and measure those objectives and indicators that are most relevant to them (Ontario Hospital Association 1999; Urrutia and Eriksen 2005).

Since 1998, the Hospital Report Research Collaborative (HRRC) have developed methods and reports on hospital performance in Ontario, using the balanced scorecard format, resulting in one of the most comprehensive sets of internationally available performance measurement reports in the public domain (Ontario Hospital Association 1999).

In the 1999 Hospital Report (Ontario Hospital Association 1999), the Ontario Hospital Association introduced and subsequently enhanced balanced scorecards for Ontario hospitals. The original perspectives were adapted to describe four broad areas (quadrants) of activities and outcomes considered more relevant to healthcare evaluation. The adapted perspectives cover assessment in the areas of Patient Satisfaction, Financial Performance, Clinical Utilisation and Outcomes and System Integration and Change (see Figure 2.9).

• **Patient Satisfaction:** Examines patients' perceptions of their hospital experience including their perceptions of overall quality of care, outcomes of care, and unit-based care.

• **Financial Performance and Conditions:** Describes how hospitals manage their financial and human resources. It refers to a hospital's financial health, efficiency, management practices, and human resource allocations.
• **Clinical Utilisation and Outcomes**: Describes the clinical performance of hospitals and refers to such things as access to hospital services, clinical efficiency, and quality of care.

• **System Integration and Change**: Describes a hospital’s ability to adapt to its changing health care environment. More specifically, it examines how clinical information technologies, work processes, and hospital-community relationships function within the hospital system.

( Ontario Hospital Association 1999)

![Figure 2.9 The Balanced Scorecard Perspectives in Healthcare as Adapted by the Ontario Hospital Association (Ontario Hospital Association 1999)](image)

Urrutia and Eriksen (2005) have also extended Kaplan and Norton’s work by implementing a new perspective focusing on the social demographics of the hospitals local operating environment. Several factors are used including fertility index, aging index, dependency index and population assignment. It is suggested that without such a perspective, provision of hospital services that are relevant and in tune with the local patient population is difficult. This perspective addresses the hospital’s environment and provides socio-cultural information related to patient reaction and behaviour patterns (Urrutia and Eriksen 2005).
Such extensions to the original BSC work now see a growing number of HCOs adopting the Balanced Scorecard technique as a way of managing their human and physical resources and the resulting quality of patient care. This is due in part to the increasing public scrutiny that HCO’s are being subjected to and has led to the development of new corporate-wide indicators that better reflect the healthcare environment (Ontario Hospital Association 1999; Lemieux-Charles et al. 2003; Urrutia and Eriksen 2005). This research will use the OHA BSC adaptations.

2.4.4 Conclusions and Implications for Patient Journey Modeling Research

High level objectives and targets outlined in the HCO strategy become the driver for process improvement measurement criteria at the operational level. The analysis of variances to these expected targets help executive management to determine if the strategy is being or will be met. Use of the Balanced Scorecard Perspectives drive the definition of a clear and concise HCO strategy and operationalisation of the high level targets are at the grass roots level of process redesign activities.

In the complex environment of healthcare reporting, *alignment* of operational activities and measurements to the strategic direction of the organisation is critical. When structures, processes and culture aren’t closely and carefully aligned with strategy, the organisation almost invariably suffers and struggles to meet strategic targets. *Alignment* is the creation and development of the structures, processes and culture that stimulate the people inside an organisation to make the right choices in the thousands of actions and decisions they confront each day (Koopman 1999).

The research within this section demonstrates that (adapted) Balanced Scorecards (BSCs) are helping healthcare organisations to define and operationalise their strategy in a more concise manner. This suggests that improvement architectures that represent the healthcare provider strategy using a BSC approach can be of benefit to healthcare improvement programs. It is also critical however that the measures defined in the BSC perspectives are explicitly linked to the redesigned operational processes. That is, each and every metric that is set for a process that is to be enacted as part of a patient’s journey must be able to be traced back to a strategic BSC.
However in the main, current healthcare process modeling techniques fail to accommodate this. Value stream maps (Lean Thinking), flowcharts and swimlane models (BPMN) do not consider the organisation’s strategy or how the measurement of operational activities can be linked to the strategy. ARIS does consider the analysis of the business strategy but does not have any mechanism for explicitly linking the strategy to a process, its enactment or its performance evaluation metrics, at the operational level.

This indicates that the structures, processes and culture resulting from healthcare redesign efforts may not be fully aligned with the healthcare provider strategy, leading to a failure to meet pre-defined strategic targets.

Chapter 3 now considers the use of readily available technologies as an enabler of the concepts described in this chapter.
CHAPTER 3
LITERATURE REVIEW - PART B

3.1 Introduction

Chapter 3 forms the second part of the literature review for this research and addresses with the key areas of study in relation to technology’s role in supporting healthcare redesign. Whereas Chapter 2 dealt with process improvement in relation to modeling the improved patient journey and linking this to the organisation’s strategy, this chapter is concerned with the role technology can play as a key enabler in the march towards improved healthcare services.

The review of readily available technology for the purposes of supporting patient journey modeling activities speaks to research hypothesis 4.

Jensen et al. (2006) state that “technology should always be marshaled in the service of a simple but important goal – quality, safety and service.” (p.122) This statement supports the goals of this research and indicates that valid areas of investigation still exist in the bid to deliver such technology support goals.

From Chapter 2 it can be seen that the push for healthcare reform has necessitated a review of the incumbent patient journey/s and the processes being followed to deliver safe, high quality care. A key related focus area has been the use of information technology and systems to enable efficiency improvements for individual or groups of redesigned processes resulting from patient journey modeling exercises.
This Chapter will investigate the impact of a number of current technologies, the role these technologies need to play and the technological deficiencies being experienced by healthcare improvement initiatives. Several key areas are applicable in the discussion concerning technology support for patient journey modeling (PJM) including:

- Automated workflow and workflow management systems;
- Decision support for clinical decisions and performance evaluation and monitoring;
- Database design and storage; and
- Integration and transferability of information between disparate systems.

The relationship of these areas is as follows. Once the future patient journey model (FPJM) is designed, increased efficiencies may be realised through the automation of appropriate workflows in the form of workflow management systems. Complimentary benefits may also be realised by linking workflow systems to up-to-date clinical knowledge databases that are readily accessible by those delivering frontline patient care. In addition as part of workflow enactment, actual performance measurements, as identified in the FPJM exercise should be captured and made available to management to aid in ongoing decision support regarding resource allocation and utilisation. Capture and analysis of such data will be supported by advanced database designs. Consideration must also be given to how information that is applicable across information systems can be integrated and transferred when required.

Each of the above areas will be defined and their roles within the PJM landscape positioned. Open research questions concerning how well these technologies support and enable healthcare process improvement will also be addressed.

### 3.2 Workflow and Workflow Management Systems

As part of the redesigned patient journey, certain processes may become targets for automation. Automation of these workflows through the implementation of workflow management systems can increase efficiency, enable better process control and improve customer service (Adams et al. 2003).
The Workflow Management Coalition (WfMC) (www.wfmc.org) is a primary driver of research in the workflow standards development domain. Much of the research in this arena has been significantly influenced by past and continuing development work conducted by the WfMC.

3.2.1 Workflow
Workflow initiatives grew out of the office automation movement in the 1970’s, with the earliest implementation being recorded as part of a PhD thesis by Zisman in 1977. A significant contribution was made by Clarence Ellis and his ‘OfficeTalk’ software in 1980, with industry adopting the term ‘workflow’ around 1984 (Swenson 1995).

The Workflow Management Coalition (WfMC) defines workflow as:

*The automation of a business process, in whole or part, during which documents, information or tasks are passed from one participant to another for action, according to a set of procedural rules.* (WfMC 1999, p.8)

This includes the analysis and subsequent definition and redesign of the processes involved. Acknowledging the relationship and support provided by technology, or the lack thereof, is important to the overall quality improvement effort.

Automated workflow is not meant to replace existing applications, but is a means of integrating various contributing applications and therefore people, together, for the purposes of achieving a particular goal (Swenson 1995).

Not all business processes are appropriate candidates for workflow automation. Those that are best suited for consideration include processes:

- That involve a number of people;
- That require a large number of instances to be tracked;
- That take a long time to complete;
- Where mistakes are expensive;
- That involve people who are geographically dispersed.

(Swenson 1995)
3.2.2 Workflow Management Systems

The re-engineering, sequencing and automation of workflow processes can be facilitated by the introduction of workflow management systems (WfMC 1995).

A workflow management system (WfMS) is defined as:

A system that defines, creates and manages the execution of workflows through the use of software, running on one or more workflow engines, which is able to interpret the process definition, interact with workflow participants and, where required, invoke the use of IT tools and applications. (WfMC 1999, p.9)

The key benefits of WfMS include improved efficiency, better process control, improved customer service, higher maintainability and business process evolution (Adams et al. 2003). Such systems can provide automated support for enterprise-wide processing including clinical, management and administrative tasks.

A WfMS is characterised by:

a) the integration of processes and tools to describe and implement the workflow;

b) the analysis of information flows to detect bottlenecks and discover anomalies to standard practice; and

c) the description of the workflows and the steps within them, relationships between the steps, required pre and post-conditions and the rules for transition between flows (Bricon-Souf et al. 1999).

Figure 3.1 depicts the characteristics of the basic workflow system. Initially processes are analysed and models developed (PJMs in the case of this research). Processes that are to be automated are described using machine interpretable languages such as XML.

These definitions are fed to the WfMS for implementation and enactment. Users interact with the WfMS and other applications during the conduct of their work.
A number of researchers have investigated the introduction of WfMS into the Healthcare domain as a means of improving the efficiency and quality of services provided (Bricon-Souf et al. 1999; Anyanwau et al. 2003; Anzbock and Dustdar; Browne et al. 2003; zur Muehlen 2004). Such projects have involved workflows within an ICU and for medical imaging and enterprise process integration. Although these projects have reported some improvements, these and other workflow literature indicates that WfMS have difficulty supporting mission-critical processes that are often multifaceted, dynamic and require complex exception handling: a common combination of features in many healthcare pathways (Bricon-Souf et al. 1999; Chiu et al. 1999; McGregor 2002; Adams et al. 2003; Anyanwau et al. 2003; zur Muehlen 2004).
3.2.3 Workflow Management Coalition

The Workflow Management Coalition (WFMC) was founded in 1993 for the purposes of creating and contributing to process related standards and educating the market on related issues. It is the only standards organisation that concentrates purely on processes. The WFMC is a global organisation of adopters, developers, consultants, analysts, as well as university and research groups engaged in workflow and Business Process Management (BPM) (www.wfmc.org).

The WFMC created XML Process Definition Language (XPDL), the leading process definition language used to describe, store and exchange process models. The WFMC has over 300 member organisations worldwide, representing all facets of workflow, from vendors to users, and from academics to consultants (www.wfmc.org).

A key development of the WFMC is the Workflow Reference Model as shown in Figure 3.2. The Reference Model identifies the common characteristics of workflow systems and defines 5 discrete functional interfaces through which a workflow management system interacts with its environment (WFMC 1995).

![Figure 3.2. The WFMC Reference Model (WFMC 1995)](image-url)
The key to the 

Reference Model is its approach to interoperability. In short any type of tool can be used for the conduct of the outer most boxes (ie: process definition, administration and monitoring, workflow engines etc...), the only requirement is that they ‘communicate’ with the workflow enactment service via a standard pre-defined ‘interface’ (WfMC 1995). There are five standard interfaces defined, each addressing a particular component of the Reference Model.

**Interface 1** supports the exchange of process definitions between external business process modeling tools and the workflow enactment service. The interface includes a common Meta-Model for describing the process definition and also an XML schema to facilitate the interchange of process definitions between separate products. The specific language used to define the processes exchanged is known as XML Process Definition Language or XPDL (WfMC 2005). XML is a common language for exchanging information amongst disparate systems and will be further discussed in Section 3.4.

**Interface 2** facilitates client application integration with different workflow systems. It particularly supports the principle of portability and reuse within different workflow management systems. The interface is specified as a series of workflow Application Programme Interfaces (APIs) that allow the control of process, activity and worklist handling functions (Hollingsworth 2004).

**Interface 3** was designed to provide a common framework for 3rd party vendors to integrate other industry applications and services with the Workflow Engine and Workflow Enactment Services. This interface is a set of standard API’s similar to Interface 2 (WfMC 1998).

**Interface 4** supports process automation across multiple disparate application implementation platforms. This interface provides for interoperability of the same business processes in different operating environments (WfMC 1995).

**Interface 5** allows consistent audit and administration of workflow cases across various systems. It defines a common model for audit data and recording which is output to workflow administration and monitoring tools (WfMC 1995).
3.2.4 Conclusions and Implications for Patient Journey Modeling Research

One of the goals of patient journey redesign is to consider what workflow processes should be automated and how these automated processes will be integrated with the remaining manual processes. In this environment it is apparent that Workflow Management Systems (WfMS) may offer some of the benefits required by healthcare redesign projects including opportunities to automate appropriate workflows to improve efficiencies, increase process control and improve patient services. However further investigation of how WfMS can be effectively introduced to the patient journey modeling and design process is needed and should be viewed as an integral component of proposed process improvement methods.

Consideration needs to be given to the definition of the processes identified as part of the future patient journey model and how these definitions will be fed/transferred to an implementation environment. In addition although there is a general push to automate wherever possible, designers and developers must remain cognisant of the fact that some workflow literature indicates that WfMS have difficulty supporting mission-critical processes that are often multifaceted, dynamic and require complex exception handling: a common combination of features in many healthcare pathways (Bricon-Souf et al. 1999; Chiu et al. 1999; McGregor 2002; Adams et al. 2003; Anyanwau et al. 2003; zur Muehlen 2004).

As discussed above, the Workflow Management Coalition (WfMC) has defined the standards for a Workflow Reference Model and associated XML Process Definition Language (XPDL) and these will be used to define the patient journey processes within the context of this research, specifically Interfaces 1 and 5 (WfMC 1995; WfMC 2005).

The Workflow Reference Model Interface 1 will be used to define those processes that have been identified as candidates for automation as part of the future patient journey model. Definition of the XPDL documents will allow the processes being automated, to be described in machine interpretable language and input directly to a workflow management system for implementation. An example of the XPDL process definition relating to the case study used in this research is included in Appendix C.
As part of the enactment of the workflow processes, specific measurements, as identified as part of the FPJM, will need to be captured and transmitted to a decision support system for management analysis and evaluation. This will necessitate the use of Interface 5. Extensions to the XPDL as reported by McGregor (2002) will be utilised for this purpose along with additional enhancements as required for PJM. The case study example of the Interface 5 XML as adapted for this research can be found in Chapter 8.

Additional extensions are required to both Interface 1 and 5 to accommodate the definition of specific patient journey metrics and to relate these back to the healthcare strategy and associated balanced scorecards. Consideration is also given to categorising processes by treatment stream and type (i.e.: initial admittance or re-admittance) and explicitly linking relevant policies and guidelines to the processes involved in the workflow.

### 3.3 Decision Support

*Management is a process by which organizational goals are achieved using resources.* (Turban *et al.* 2005, p.7)

Decision making is an integral part of the management of any kind of organisation (Harrison 1999) and using Turban’s perspective, decision making forms a facet of almost every activity a manager is required to perform in their daily operations. Management in healthcare is no exception. In the context of this research we are considering decisions made regarding the effectiveness and impact on outcomes of changes made as a result of redesigning a particular patient journey.

To understand the support technology can provide for healthcare decision makers, it is first relevant to describe the types of decisions that are made and the decision making process typically undertaken. It is then possible to identify where
technology is able to make the most beneficial contributions. The impacts decision support technology had on this research is also addressed.


3.3.1 Decision Making Process
A review of the management literature sees general agreement that a decision is a choice, typically about a course of action and the commitment of resources (Simon 1960, as in Gorry and Scott Morton 1977; Gorry and Scott Morton 1971; Mintzberg et al. 1976; Sprague Jr and Watson 1996).

However Simon (1960, as in Gorry and Scott Morton; 1977) also states that decision-making processes exist on a continuum that ranges from highly structured (or programmed) to highly unstructured (or nonprogrammed). Structured problems are routine and repetitive for which standard rule sets and solutions can be defined. Unstructured problems are unique and complex, and for which no standard rule sets or solution method can be pre-defined (Gorry and Scott Morton 1971; Simon 1977; Turban et al. 2005). Simon goes onto state that all decision-making problems can be broken down into three phases, namely: Intelligence, Design and Choice as shown in Figure 3.3.

![Figure 3.3. Simon's Original Decision Making Process (Simon 1960, as in Gorry and Scott Morton 1977)]
Complimentary research by Mintzberg et al. (1976) evaluated 25 types of ‘strategic’ decision processes used in organisations. (NB: In Mintzberg’s work ‘strategic’ relates to the importance of the decision to the organisation). Through a process of rationalisation this work resulted in the development of a general model of the strategic decision process as shown in Figure 3.4. This model includes not only the phases of the decision making processes but also the cognitive tasks that are performed by the decision maker.

![Figure 3.4. A General Model of the Decision Making Process (Mintzberg et al. 1976)](image)

It follows then that a decision support system must provide support to the decision maker as they enact the decision making process.

### 3.3.2 Decision Support Systems

The term decision support system (DSS) was suggested in Gorry and Scott Morton’s seminal paper “A Framework for Management Information Systems” in 1971. Sprague and Watson (1996) indicate that DSS evolved as research discipline in its own right during the 1980s.

In 1965 Anthony developed a taxonomy for managerial activity consisting of three categories:

**Strategic Planning:** the process of deciding the direction and objectives of the organisation and the activities and means (resources) required to achieve these objectives.
**Management Control:** the process managers undertake to ensure required resources are obtained and used effectively and efficiently to achieve the organisational objectives.

**Operational Control:** the process of ensuring that operational tasks are carried out effectively and efficiently.

(Anthony 1965, as in Gorry and Scott Morton 1977)

Anthony further posited that the managerial activities within these categories varied distinctly enough to warrant development of different types of systems.

Using Simon’s unstructured and structured decision making paradigm and Anthony’s managerial activity categories, Gorry and Scott Morton (1971) developed a framework that classified problems and suggested appropriate tools for solving such problems. Their framework is shown in Figure 3.5. This framework introduces a new term, ‘semi-structured’, when discussing the types of decisions made. *Semi-structured* refers to decisions where some but not all of the decision making phases are formally structured. Decision support systems are most valuable at the *semi-structured* and *unstructured* decision levels (Gorry and Scott Morton 1971; Turban *et al.* 2005).

![Figure 3.5. Information Systems: A Framework (Gorry and Scott Morton 1971)]
A variety of definitions abound for DSS (Sprague Jr and Watson 1989; Holsapple and Whinston 2001; Turban et al. 2005) although all centre around a number of key items that are summarised in Keen and Scott Morton’s three objectives for a DSS:

- To assist managers in making decisions to solve semi-structured problems.
- To support manager’s judgement as opposed to replacing it.
- To improve a manager’s decision making effectiveness rather than its efficiency.

The main difference between a Management Information System (MIS) and a Decision Support System (DSS) is the degree of structure of the problem to be solved (Keen and Scott Morton 1978; Sprague Jr and Watson 1996).

### 3.3.3 Decision Support System Architecture

Now that a general understanding of the purpose and use of DSS is available, it is appropriate to discuss the structure and makeup, that is, the architecture, of the systems themselves.

Sprague Jr and Watson (1996) state that the technology required in a DSS must support three distinct functions: Dialog, Data and Modeling. This is known as the DDM paradigm and the architecture for this is shown in Figure 3.6. Turban et al. (2005) include a ‘knowledge’ component between the Dialog and Data/Modeling levels. This represents the organisation’s existing knowledge base or repository.

![Figure 3.6. The DDM Paradigm (Sprague Jr and Watson 1996)](image-url)
For the purposes of this research, the DSS architecture will be discussed using the DDM Paradigm of Sprague Jr and Watson (1996).

**Data subsystem**

The data required by decision makers typically comes from a variety of sources, both internal and external to the organisation. It is also not uncommon that decisions require some sort of summarisation and/or analysis during the decision making process. The collection and aggregation of this information necessitates special procedures and data storage mechanisms. This suggests that a DSS requires a dedicated database separate to that used to process everyday transactions. Such dedicated databases take the form of a Data Warehouse (Sprague Jr and Watson 1989; Turban *et al.* 2005).

Bill Inmon is recognised as the ‘father’ of the data warehouse movement (Gill and Rao 1996; Kimball 1996) and defines the data warehouse as a:

> “**Subject oriented, integrated, non-volatile, and time variant** collection of data in support of management’s decisions.” (Inmon 1996, p.31)

The key aspects of this definition are: **subject oriented, integrated, non-volatile** and **time variant** and these require further explanation in a bid to differentiate them from everyday transaction processing systems, such as an insurance company claims system.

**Subject Oriented:** Typically data warehouses are grouped around the major subject areas of organisational interest such as customer, policy, premium, and claim.

**Integrated:** Probably the most important aspect of the data warehouse, integration refers to the process of extracting data from a variety of operational systems and translating it into the same format/language. For example, consider how a customer’s sex may be stored. In one system it may be coded as ‘m’ or ‘f’, in another ‘0’ or ‘1’, and in another ‘male’ or ‘female’. The data warehouse integration process converts all of these variations into an agreed format for storage in the data warehouse. This is also known as data ‘cleansing’.
Non-volatile: Whereas data in transactional systems are updated frequently, information stored in the data warehouse is typically read only. Following extraction, integration and upload of data, en masse from a number of transaction systems, users of the data warehouse are usually most interested in querying and analysing the information for management decision purposes: not for adding new or updating existing records.

Time variant: The time periods of interest are considerably longer in the data warehouse environment than that of transactional systems. In transactional systems we may be interested in this year’s data, transaction by transaction. Whereas in a data warehouse managers are interested in data up to 10 years old, usually at a summarised or aggregated level of some type. Transactional databases also contain up-to-date data as at the time of enquiry. Data warehouse data is not much more than a series of snapshots, taken at particular points in time. The key structure of data warehouse data will always contain some element of time, indicating the period of aggregation such as week, month and/or year. This is not always the case in transactional systems (Inmon 1996)

![Figure 3.7. The General Data Warehouse Architecture](adapted from (Sprague Jr and Watson 1996))
Figure 3.7 illustrates the general principles of the data warehouse architecture as adapted from Sprague and Watson (1996). In the first instance, systems containing information of managerial interest are identified. Programs are written to extract the required data from the transactional systems and the data is cleansed and integrated. The integrated data is then loaded into the data warehouse. The data warehouse information is then made available for query and analysis in managerial decision making. Specific subsets of the data warehouse can also be created for specialised areas or functions. These subsets are known as data marts. (Inmon 1996; Kimball 1996)

Model subsystem
The model subsystem contains routine and specialised statistical, financial, forecasting, management science and other quantitative models that provide the analysis capabilities within the DSS. Turban et al. (2005) suggest that models stored in the Model subsystem can be categorised as strategic, tactical, operational or analytical, thus supporting Anthony’s (1965) management levels. Models in the Model subsystem are linked with the data in the data subsystem. Models can extract parameters, coefficients and variables from the data subsystem and enter results of the model’s analysis and computation into the data subsystem. These results can then be used by other models later in the decision making process (Sprague Jr and Watson 1996).

Dialog subsystem
The Dialog function is also known as the user system interface and is how the user interacts with the DSS. The Dialog function is made up of three components: the data base management system (DBMS), the model base management system (MBMS) and the dialog generation and management system (DGMS). The DBMS and MBMS manage the administration of the data and models required as part of the decision making process. The DGMS manages the interface between the user and the rest of the system (Sprague Jr and Watson 1989).

3.3.4 Modeling the Data Warehouse
Due to the multiplicity of data dimensions that need to be accommodated in a data warehouse, traditional entity relationship modeling of the data warehouse database is
insufficient. Modeling of the data warehouse information structure is therefore facilitated using two similar but specialised techniques:

- Star Schema
- Snowflake schema

**Star Schema**

The star schema is the simplest data warehouse database design and the easiest to understand. It gets its name from the shape the model makes as it is created; a central ‘fact’ table with multiple related ‘dimension’ tables surrounding it, as shown in Figure 3.8.

![Figure 3.8. An Example of a Star Schema (Kimball 1996)](image)

The fact table is typically in third normal form (3NF) with the dimension tables being de-normalised to second normal form (2NF) (Kimball 1996).

This means that each dimension table has a primary key, with descriptive data relative to its primary key. The primary key is used to constrain and group data as part of the data warehouse queries. The fact table is then made up of all the primary keys from the dimension tables (a compound or composite primary key) and additional aggregated numeric attributes or facts (Kimball 1996).

**Snowflake Schema**

A more complex variation of the Star schema is the Snowflake schema. This additional complexity is due to the fact that the tables which describe the
surrounding dimensions are more highly normalised (Gill and Rao 1996). This linking to additional tables gives the schema its shape and hence the name, snowflake. Originally introduced by Saylor et al. (1995), snowflake schemas were meant to overcome the deficiencies of the star schema, such as reducing sparsity and redundancy, thus saving storage (Saylor et al. 1995; Gill and Rao 1996). Kimball argues however that snowflaking is irrelevant to the issue of planning the disk capacity (storage space required) of a data warehouse. He also warns against snowflaking to avoid intimidating the user with the number of tables held in the data warehouse and the complexity more tables adds to the queries that need to be written. In addition he suggests that the use of this type of schema will lead to poor data warehouse browsing performance (Kimball 1996).

Figure 3.9 shows the previous star schema example (Figure 3.8) as a snowflake schema.

![Figure 3.9. An Example of a Snowflake Schema (Kimball 1996)](image)

### 3.3.5 Implementing the Data Warehouse

A multidimensional database (MDDB) is a type of database that is optimised for data warehouse and online analytical processing (OLAP) applications. OLAP permits a sophisticated multi-dimensional analysis of data that can, in turn, be used for decision making purposes.
Key characteristics of an OLAP application include (Oracle 2005):

- trend analysis over sequential time periods
- slicing subsets for on-screen viewing
- drill-down to deeper levels of consolidation
- reach-through to underlying detail data
- rotation to new dimensional comparisons in the viewing area.

Conceptually, a MDDB uses the idea of a data cube to represent the various dimensions of data available, thus allowing a user to view aggregated data from a number of perspectives (Oracle 2005).

MDDBs are typically designed using a Star or Snowflake schema (Kimball 1996; Inmon et al. 1999). Both techniques make multi-dimensional database (MDDB) functionality possible using traditional relational database tools. This is required due to the large investment organisations already have in relational technology.

### 3.3.6 Decision Support in Healthcare

Within the healthcare domain two main types of Decision Support Systems exist:

1. Clinical Decision Support Systems (CDSS) and

An emerging area is also decision support systems for patients to aid in simple self-diagnosis and ‘where-to-seek’ care advice as well as in more sensitive areas such as end-of-life decisions.

This research is primarily concerned with DSS used within the physical healthcare provider organisation and as such will deal with the first two types of DSS mentioned above, namely CDSS and MDSS. These systems serve two different populations. CDSSs serve the clinician and healthcare worker delivering patient care on the frontline and MDSSs serve those responsible for performance monitoring and the overall running of the healthcare unit and the allocation and monitoring of organisational resources including staff, equipment and budgets.
Clinical Decision Support Systems
Clinical Decision Support Systems (CDSS) can be used to deliver information required in the diagnosis and treatment of patients including “evidence-based best practice” standards at the point of care (Hanson 2006). CDSS can be used in a wide variety of activities including generation of reminders, prompts and alerts of possible allergies and/or lab tests needed, drug prescription and contraindications, diagnosis, disease management, education and knowledge currency (Coiera 2003). Research studies have shown that the benefits of using CDSS include improved clinician performance, improved compliance with clinical pathways and guidelines, positive effects on patient outcomes, reduced costs of medical care and reductions in medication errors and adverse events (NSW Department of Health 1997; NEDST 2002; Coiera 2003; Westbrook et al. 2004; Kawamoto et al. 2005; Ahamed et al. 2006; Hanson 2006).

The earliest clinical decision support systems were developed in the 1970’s and 1980’s in the U.S. In 1974, Myers and Miller from the University of Pittsburgh developed INTERNIST-1. This system was designed to address diagnostic issues in the fields of internal medicine and neurology. Based on observations about a patient, the system deduced a possible set of compatible diseases. By prioritising the possibilities and asking more questions the system narrowed the set or suggested a single best choice. When compared to experts using cases from the New England Journal, the system performed competently. INTERNIST-1 was eventually commercialised as Quick Medical Reference (QMR) (Hanson 2006).

The next notable CDSS was designed by Dr Edward Shortliffe at Stanford University in the mid-1970’s. Known as MYCIN, the system simulated an infectious disease specialist and used sets of IF-THEN rule pairs and associated weightings to determine the most likely diagnosis. MYCIN was designed to be used by internists to assist in knowledge extension and currency (Hanson 2006).

In the 1980’s, the Massachusetts General Hospital developed Dxplain. This system stores approximately 2200 diseases and 5000 symptoms and is now a commercially available product (Coiera 2003).
In the late 1990’s the New South Wales (NSW) Department of Health initiated the Clinical Information Access Program (CIAP). CIAP “provides information and resources to support evidence-based practice at the point of care”. It is available online to all staff working in the NSW public health system 24 hours a day. This system provides access to information to support care processes, enables clinicians to consult with clinical colleagues online, shares clinical pathways statewide and improves clinician-clinician and clinician-patient communication and collaboration (NSW Department of Health 1997).

A CDSS can act in one of three modes: Passive, Semi-active and Active. Passive CDSS are provided with input with an implicit request for a response. An example could be where a new intern inputs patient symptoms and asks for possible diagnoses. Semi-active CDSS sit in the background and prompts the care deliverer with reminders to act. An example may be a reminder that an inoculation is due or the management of alarm levels for physiological variables such as heart rate and blood pressure. An Active CDSS intervenes automatically without the need for human confirmation. An example includes managing the weaning off mechanical ventilation (Hanson 2006).

**Computer Interpretable Guidelines**

An emerging area of interest associated with CDSS is the implementation of machine-readable clinical practice guidelines or computer-interpretable guidelines (CIGs). The Institute of Medicine defines practice guidelines as “systematically developed statements to assist practitioner and patient decisions about appropriate healthcare for specific clinical circumstances” (Field and Lohr 1990). Clinical practice guidelines have been developed to reduce unjustified variations in clinical practice, with the goal to improve quality and contain costs (Field and Lohr 1992). De Clercq et al. (2004) state that implementing guidelines in computer-based decision support systems (ie: CDSS) promises to improve acceptance and application of guidelines in daily practice because the actions and observations of health care workers are monitored and advice is generated whenever a guideline is not followed. Wang et al. (2002) also report on several studies that have shown that when CDSSs are developed to provide case-specific assistance in decision making and are integrated with clinical workflow, they can improve clinicians’ compliance with
clinical practice guidelines. The key research question in this area is how to create computer interpretable representations of clinical knowledge contained in clinical guidelines. Several research groups are attempting to develop guideline representation languages with most approaches taking a ‘task-based paradigm’ in which guidelines are decomposed into a hierarchy of tasks (Coiera 2003).

The more significant guideline representation languages include:

- Arden Syntax;
- The Guideline Interchange Format (GLIF);
- PROforma;
- Asbru;
- Prodigy;
- Protégé.

(NEDST 2002; Wang et al. 2002; Coiera 2003; de Clercq et al. 2004)

The domain of CIG research is primarily concerned with the outputs of the logical model of the new patient journey as it relates to the physical design of an automated support system. It looks at ways to implement a formal structure to the process outputs and is not overly concerned with the development method for the logical models themselves. As part of this research, a review of several guideline languages, found that in some instances flowcharts, state transition diagrams and uni-directional graphs are used to model the logical process flow but that the use of a formal modeling structure was absent. Peleg (2003) and Wang (2002) suggest this is a major restriction in the mainstream computerisation of clinical guidelines (Wang et al. 2002; Peleg et al. 2003).

However despite almost 30 years of work on clinical decision support systems, Hanson (2006) and Westbrook et al. (2004) suggest that they have still not been widely integrated into medical practice. Many reasons have been surmised for this slow uptake, including the relatively slow penetration of computers into medical practice, compared to other industries and the lack of integration with workflows.
Where DSS successes have been reported the critical success factors include:

- Integration with other key technologies such as Electronic Health Records (EHR) and Computerised Physician Order Entry (CPOE);
- Integration with workflows to support not only the processes but organisational structure as well;
- Inclusion of clinicians in the development process prior to deployment to reduce local cultural issues and increase the feelings of system ownership;
- Integration of decision support tools into hand-held devices and familiar web browsers to facilitate point-of-care delivery;
- Justification of suggested courses of action based on evidence.

(Kawamoto et al. 2005; Ahamed et al. 2006; Conrick 2006; Hanson 2006)

Management Decision Support Systems

In business management circle these types of decision support systems are known simply as Decision Support Systems (DSS). They have been named Management Decision Support Systems (MDSS) here purely for the reasons of differentiating them from clinical decision support systems as discussed above.

Management is a process by which organisational goals are achieved using resources. The resources are the inputs and the attainment of goals is the output of the processes performed. Fayol (1916) identified five functions of a manager: planning, organising, commanding, coordinating and controlling (POCCC) (as in Holsapple and Whinston 2001). Urwick (1943) enhanced these function with two additional functions, that of forecasting and investigation (as in Holsapple and Whinston 2001).

Planning:  Is the formulation of the things that need to be done and the methods to accomplish those things. Planning is conducted in respect to the organisation’s resources, in light of the organisational goals to be achieved.

Organising:  Is concerned with the structure and attainment of human and physical resources as per the plan.
**Commanding:** Involves issuing specific or general instructions that cause the plans to be put into action. It implies the transference of knowledge from the manager to other elements (people or computers) within the organisation.

**Coordinating:** Is concerned with the manager’s efforts at interrelating and harmonising planned activities as they are carried out.

**Controlling:** Is the function of ensuring that the plans are carried out as required.

**Forecasting:** Although often used as part of planning, forecasting can be considered and conducted as a separate activity. It involves estimations or predictions of what may occur in the future based on past and current conditions or performance. It may also consider events that are known to be occurring in the future and their impact.

**Investigation:** Involves conducting research for the purposes of acquiring increased knowledge. This may pertain to industry trends, competitors, technology or similar.

(Holsapple and Whinston 2001; Turban et al. 2005)

Management Decision Support Systems must then support those responsible for conducting the managerial functions above. In real terms this translates to ‘POCCcing’ the performance and productivity of the organisation resources over time and using *Forecasting* and *Investigation* to support these functions. All activities equally relevant in Healthcare.

Such activities typically have a great deal of focus on the organisation’s resources. Holsapple and Whinston (2001) suggest that there are four type of organisational resources, namely: money, materials, humans and knowledge. This is represented in Figure 3.10 along with the transformation of inputs to outputs.
In the healthcare environment these relate to budgets, physical resources such as x-ray machines and the resulting x-rays, human resources such as clinicians, nurses, midwives, administration assistants and educators and knowledge such as patient safety levels and outcomes. It is important to note that within the healthcare setting these resources are associated with a wide variety of activities including patient administration, patient care delivery, inter-department/service transfers, internal and external service/product providers and staff, as an example.

Therefore MDSS within healthcare must accommodate the capture, storage and analysis of the measurement information required to support the managerial functions associated with these resource types. Jensen *et al.* (2006) define a measure as “an indicator of change” and state that “a measure is used to track the delivery of proven interventions to patients and to monitor progress over time”. (Jensen *et al.* 2006, p.176). Berwick (1996) further suggests that measurement is also about learning and can be used to gain more knowledge about required changes.

As part of the design of the MDSS a measurement framework must be defined. This will involve identification of the data required to be extracted from the operational systems such as time to complete patient processes, number of patient days, types of cases serviced etc. This information will then need to be cleansed and summarised as required and loaded into the data warehouse. The MDSS must then provide facilities for the query, analysis, what-if scenario forecasting and reporting needed by healthcare managers for organisational management and ongoing goal attainment.
A key source of measurement data are derived from standards bodies such as JCAHO’s ‘Specification Manual for National Hospital Quality Measures’ and the ACHS’s ‘Clinical Indicator Information 2007’ (JCAHO 2006; ACHS 2007). Other recognised examples can be found in Jensen et al. (2006).

Following population of the MDSS database, management can begin to monitor and analyse the stored data. Such analysis can be enhanced through the provision of ‘Dashboards’. Dashboards highlight where unacceptable variations are occurring typically through the use of colour-coded cells or graphs. This can bring immediate attention to problem areas without the need for a human to traverse the data. More sophisticated systems can capture data in ‘real-time’ with variations alerted instantaneously with either colour and/or sound (Jensen et al. 2006).

3.3.7 Conclusions and Implications for Patient Journey Modeling Research

This section looked at the extensive field of technology support for decision making within organisations. It covered a number of related areas including the decision support system architecture, data warehouses and decision support in healthcare.

Two classifications of Decision Support Systems are relevant in the context of redesigning healthcare and will be included in the patient journey modeling meta-methodology: Clinical Decision Support Systems (CDSS) and Management Decision Support Systems (MDSS).

**Clinical Decision Support Systems (CDSS)** - When redesigning processes involved in a given patient journey the redesign team must consider the application of clinical guidelines and evidence-based best practice where appropriate. CDSS provide current knowledge about diseases, treatments, drug interactions and risk profiles. When efficiently integrated into other components of patient care such as EHR and CPOE, CDSS represent a huge opportunity for the delivery of safe, cost-effective, evidenced-based medicine to patients.

The patient journey modeling meta-methodology presented in this research will include the input of practice guidelines to the patient journey modeling activity and the linking of relevant guidelines to specific processes within the patient journey.
CDSS are used as the implementation vehicle for the capture and storage of clinical guidelines and to assist with compliance to same, thus further improving outcomes in the new patient journey.

*Computer Interpretable Guidelines (CIGs)*- Studies in the development of strategies to implement Computer Interpretable Guidelines (CIGs) have shown that computer-based clinical decision support systems (CDSSs), when developed to provide patient-specific assistances in decision-making and integrated with clinical workflow, can improve clinicians’ compliance with CIGs and improve patient outcomes (Wang *et al.* 2002).

As work into CIGs is mainly concerned with the physical design, construction and implementation issues associated with patient journeys and their related clinical guidelines, CIG research does not form a core component of the current research.

**Management Decision Support Systems (MDSS)** - MDSSs must support those responsible for conducting the managerial functions of Planning, Organising, Commanding, Coordinating, Controlling, Forecasting and Investigating. In real terms this translates to management of the performance and productivity of the organisation resources over time.

During development of the future patient journey and its associated processes, items to be measured are identified and targets for these items determined. Each and every measurement is aligned with the healthcare strategy. This forms the organisation’s measurement framework and is translated from the future patient journey model into the MDSS. As part of workflow enactment, actual item measurements are captured and fed into the MDSS for comparison to the targets. Management then analyse if the redesigned patient journey is performing as expected or if additional enhancements are required.

Automation of measurement frameworks and their evaluation (via Decision Support Systems) has been discussed by McGregor (McGregor 2002; McGregor 2003) but only in relation to process measurement within a business context. Options for automated measurement and evaluation of process improvements within a healthcare
context is lacking and needs attention if care redesign initiatives are to survive the scrutiny of senior healthcare management.

Inclusion of automated measurement frameworks and evaluation in the meta-methodology assists in measuring the degree of effect of any changes made to the patient journey/s under review. Such justification is invaluable if the new and improved patient journey/s are to be proposed as a benchmark practice within a service or across the healthcare industry.

Within this research modeling of the MDSS database is done using the Star Schema approach. This ensures that the multi-dimensional nature of the patient journey is appropriately captured and presented for management analysis.
3.4 Integration and Transfer of Information Between Systems

As part of the design of the improved patient journey, opportunities to share and move data between existing and possibly new applications will become apparent. The eXtensible Markup Language (XML) is a widely used technology for facilitating such data transportation between applications. More recently, enhanced versions of XML have been specified as a method to transport information concerning Balanced Scorecards, Business Processes and Workflows. The following will explore the origins of XML and its associated components and investigate their relationship to the research areas.

3.4.1 eXtensible Markup Language (XML)

The fundamental concepts of the eXtensible Markup Language (XML) and its related languages/specifications is to enable the data description to be separated from the way the data is presented and to provide a standard self-describing format that is readable by both computers and people (Mercer 2001). Originally designed to meet the challenges of large-scale electronic publishing, XML is now playing an increasingly important role in the exchange of a wide variety of data between Web applications (W3C 1996; Young 2000).

Known as a markup language specification, the first draft XML standard was released by the World Wide Web Consortium (W3C) in November 1996 (W3C 1996). The current version is 1.0 – fourth edition (W3C 2006). A markup language is a set of commands that tell a program how to display content. Content may consist of words, pictures or other digitised data. Markup language commands use plain text that people can read and write quite easily (Mercer 2001).

XML is based on an earlier markup language specification, Standard Generalised Markup Language (SGML) (W3C 1996). A common SGML application used on the Web, is HTML. HTML provides a fixed set of predefined elements that you can use to markup the components of a typical, general-purpose Web page. Some element examples include headings, paragraphs, lists, tables, images and links.
Each element begins with a start tag, with most elements finishing with an end tag such as:

\(<\text{H2}>\text{My Home Page}\</\text{H2}>\)

This indicates that the words “My Home Page” will appear as a level 2 heading in the Web page browser. Although the set of predefined elements has expanded considerably, HTML is still unsuitable for defining many types of documents such as a database or music score (Young 2000).

XML overcomes such limitations due to the fact that the XML definition consists of minimal standard syntax that allows users to create their own elements and assign names that are meaningful to them. Hence the term extensible in eXtensible Markup Language (Young 2000). XML can therefore be used to describe any type of document and can then be used to exchange this information between applications on the Web.

Contents in XML are presented in an XML Document. An XML Processor then interprets the XML Document to another application. Presentation of the XML Document at the receiver end can be done using an associated style sheet and/or schema. A style sheet is a separate file that contains instructions for formatting the individual XML elements using technologies such as eXtensible Stylesheet Language (XSL).

An XML Schema can be considered as a written representation of the model to be followed by the data in the XML document and is a more advanced type of Document Type Definition (DTD) (Young 2000; Mercer 2001).

A sample XML Document is shown in Figure 3.11. The first line is the XML declaration, which identifies it as an XML document and gives the XML version number being used. Following this is the root element \(<\text{AdmittedPatients}>\). The root element contains a number of additional elements that hold information content. Each element is made up of a series of markup tags in the form:

\(<\text{tag}>\text{information content}\</\text{tag}>\)
For example:

```xml
<patient.name>Joanne Curry</patient.name>
```

Sub-categories of information can also be nested within other elements, as is the case with the `<patient.address>`, which contains nested elements of `<street>`, `<suburb>`, `<state>` and `<country>`.

```xml
<?xml version="1.0"?>
<AdmittedPatients>
  <patient>
    <patient.id>123456789</patient.id>
    <patient.name>Joanne Curry</patient.name>
    <patient.date.of.birth>September 15, 1965</patient.date.of.birth>
    <patient.address>
      <street>6 Daniel Street</street>
      <suburb>Cronulla</suburb>
      <state>NSW</state>
      <country>Australia</country>
    </patient.address>
    <patient.home.phone>02 9438 4486</patient.home.phone>
    <patient.work.phone>02 9685 9234</patient.work.phone>
  </patient>
  <patient>
    <patient.id>111222333</patient.id>
    <patient.name>Reg White</patient.name>
    <patient.date.of.birth>January 7, 1945</patient.date.of.birth>
    <patient.address>
      <street>21 Cross Street</street>
      <suburb>Lakesedge</suburb>
      <state>NSW</state>
      <country>Australia</country>
    </patient.address>
    <patient.home.phone>02 9724 3724</patient.home.phone>
    <patient.work.phone>02 9767 1234</patient.work.phone>
  </patient>
</AdmittedPatients>
```

**Figure 3.11. An Example XML Document**

To facilitate the separation of the presentation of XML documents from their content and the integration of information from multiple disparate sources, the W3C has also introduced a number of XML companion standards namely XML Stylesheets and XML Namespaces (Young 2000; W3C 2006).
XML Stylesheets
As mentioned above one of the original goals of XML was to separate the definition of data to be transferred across and between systems from its presentation at the receiver’s end. While XML data is defined in an XML document, presentation of the data requires a presentation language and transformation mechanism. The eXtensible Stylesheet Language (XSL) provides such a resource.

XSL is the XML-based language used to describe how the data in the XML document can be presented. XSL then uses eXtensible Stylesheet Language Transformation (XSLT) for the transformation process and for formatting the data at the end device. In this way multiple stylesheets can be used to present the same data in different ways for different devices or as a common tool for bringing together data from disparate systems (Young 2000; Mercer 2001).

XML Namespaces
As one of the strengths of XML, data from multiple disparate sources can be bought together as one legible group; however this brings with it some problems. For example, when data from different systems share the same name, XML recognises a naming conflict and is unable to determine which data item should be used. This can be solved through the use of XML Namespaces.

An XML Namespace provides a mechanism for identifying the location (owner) of a schema for a given set of XML data tags and by including the XML Namespace with the data tag, all naming conflicts can be resolved. Namespaces are declared using the reserved attribute xmlns with a reference to it’s ‘unified resource identifier’ (URI) location of the relevant unique data tags to be used in a given instance (W3C 2006). Once the XML Namespace is declared, data tags referring to that particular schema need to be prefixed with the XML Namespace nickname. For example if a hospital drug list used a schema named ‘dl99’, the XML Namespace declaration would be:

\[
\text{xmlns:dl99=}"http://www.nmsdrglst.com"
\]

Then whenever an attribute from the hospital drug list schema was used in an XML document, it would be prefixed with the Namespace nickname ‘dl99’. This could be used to distinguish the drugs used from a specific manufacturer’s list.
XML *Namespaces* also allow standards bodies and specific disciplines to define sets of data tags reflective of their explicit environment. This is in fact the case with the World Wide Web Consortium (W3C), Balanced Scorecard Collaborative and the Workflow Management Coalition (WfMC) (Balanced Scorecard Collaborative 2001; WfMC 2005).

### 3.4.2 Balanced Scorecard XML Standard (BSC XML)

To facilitate the definition and seamless transfer of Balanced Scorecards between applications, the Balanced Scorecard Collaborative joined with a number of partner organisations to develop the *Balanced Scorecard XML Standard* (BSC XML). Released in draft mode in 2001, BSC XML

> “will remove many of the technology and software barriers that currently exist when transferring performance management and strategy related information between some applications and across enterprises” (Balanced Scorecard Collaborative 2001, p.3)

This means that once the Balanced Scorecards are developed as part of the organisational strategy setting activity, they can be defined in *BSC XML* and transferred to and across operational systems. This will allow each and every metric set at the operational level to be explicitly linked to a specific BSC and thus ensure operational activities are aligned with strategic goals.

An example of the use of *BSC XML* and relevant extensions for business performance management can be found in McGregor’s work on Intelligent Workflow Monitoring (IW-MONS) (McGregor 2003).

### 3.4.3 XML Process Definition Language (XPDL)

The goal of the XML *Process Definition Language* (XPDL) is to provide a standard syntax for the definition, storage and exchange of business process diagrams. *XPDL* is not an executable programming language but a process design format for storing the visual diagram and process syntax of business process models (WfMC 2005).
In the context of this research XPDL is used to define a generic description of the processes identified as part of the redesigned patient journey (future patient journey model). These process descriptions can then be translated to an executable language such as *Business Process Execution Language (BPEL)* for use as workflow definitions in a variety of workflow engines (WfMC 2005; Palmer 2006). This means that the efforts put into defining and designing the new patient journey processes can be used explicitly for workflow automation without the need to introduce additional technologies.

It also means that if new workflow technologies are introduced in the future, little or no additional process specification work would be required as the XPDL and BPEL would readily support process migration to other workflow engines (Palmer 2006).

### 3.4.4 Conclusions and Implications for Patient Journey Modeling Research

This section assessed the pivotal research works in relation to *XML Documents, Stylesheets* and *Namespaces*. An additional review concerning the use of XML for defining Balanced Scorecards and Workflows was also undertaken.

There is general agreement within the computing community that XML is one of the preferred techniques for data interchange amongst disparate systems. This is confirmed with the development of new XML standards relating to other disciplines such as Balanced Scorecards and Workflows as discussed in the previous section (Balanced Scorecard Collaborative 2001; WfMC 2005). With this in mind XML will used as the definition medium for all data interchange requirements identified as part of the new patient journey model within this research. Existing standards will be used, with new extensions proposed as required.

In relation to required extensions, a new ‘patient journey model’ element is added to the BSC XML draft standard to permit the grouping of objectives based on a particular treatment stream. With reference to McGregor’s extension of the BSC XML draft (McGregor 2002), the ‘type’ element is extended to include measurement recording types relevant to the healthcare domain, such as, ‘initial admission’ or ‘re-admission’.
Similar extensions are made to the WfMC XPDL standard to accommodate the new BSC XML enhancements to ensure particular treatment streams and measurement types can be tracked as part of workflow enactment. This allows the MDSS to compare *target* measurements as set during BSC development to *actual* measurements achieved, thus helping to meet the research goal of aligning the redesign activities to the organisational strategy.
3.5 Linking of Chapters 2 and 3

Each of the areas of research discussed in Chapters 2 and 3 impacts the effective and efficient delivery of process improvements to the healthcare domain. In general, previous research has focused on raising the profile and benefits of standardised clinical practice in relation to patient safety, the inclusion of care providers and patients in the development of such practices and the provision of automated support where appropriate. A vital missing link is the analysis and development of the information and models depicting the logical aspect of the patient journey.

Figure 3.12 shows how the logical, physical and construction and implementation environments are related. The concept of separating the different levels of abstraction involved in process improvement derive from the Information Systems field of research and the resulting impacts on system development in the field of Computer Science.

![Logical Model of Patient Journey Requirements](image)

The **logical model** of the patient journey involves the analysis and representation of the requirements for an ideal patient journey, totally devoid of any technological considerations or restrictions.
Logical requirements gathering looks at the questions of what is done, who is involved, when the activity occurs and in what location it is performed. The resulting future patient journey model (the ideal situation) should be patient-centric, increase patient safety, be free from duplication of effort and excessive patient movements, reduce overall usage of resources and eliminate time wastages wherever possible.

The **physical model** of the patient journey design (middle layer) deals with what technology should be considered and how it is best applied to the delivery of the patient journey requirements outlined in the Logical Model. This can relate to the selection of a particular computer-interpretable guideline model, use of XML and HL7 as a data exchange protocol, the provision of automated workflow support and the communication techniques for process output to a particular decision support tool for variance analysis.

The **construction and implementation** of supporting information systems (bottom layer) relates to the actual building and delivery of appropriate technological solutions, based on the physical designs, to the care provider and patient community.

Chapter 2 dealt mainly with the Logical Model layer and Chapter 3 with the Physical Model layer. The construction and implementation layers are beyond the scope of this research.

The key deficiency in the above areas of research and their impact on the healthcare domain to-date, lies in the lack of standardisation of the logical model definitions in relation to the specificities associated with the complex and dynamic nature of safe and high quality healthcare delivery. The major contribution of this research addresses these deficiencies by investigating the introduction of a meta-methodology for the design and modeling of patient journeys. Such a meta-methodology provides support for:

- the inclusion of relevant healthcare provider strategies and objectives,
- linking of operational measurement criteria to the strategy,
- healthcare specific modeling tools,
• requirements for automated support in areas such as workflow and decision support and
• the identification of applicable measurement and evaluation procedures.

Coverage of these items provides solutions to research hypotheses 1, 2 and 3 as discussed in Chapter 1.
CHAPTER 4
A PATIENT JOURNEY MODELING META-METHODOLOGY

4.1 Introduction
This chapter describes an original domain specific improvement architecture in the form of a Patient Journey Modeling Meta-Methodology. The Patient Journey Modeling Meta-Methodology is known as $PJM^3$ and is expressly designed to support patient journeys in the context of process redesign within the healthcare domain for the purposes of increased patient safety, reduced variations of care and overall outcome improvement.

The main motivation for the development of the new Meta-Methodology is the lack of a domain specific process redesign technique for patient journey modeling initiatives. Chapter 2 outlined the current modeling techniques being used within the healthcare arena and the fact that all of these techniques are from other industries such as manufacturing, business and computing. This has led to some frustration for healthcare improvement teams as they are unable to capture the nuances associated with the complex nature of holistic healthcare redesign (Laursen 2003).

Development of $PJM^3$ involved aspects of method reconciliation and consolidation as well as the addition of specific dimensions unique to healthcare such as patient needs and practice guidelines. Initially a number of patient journey modeling subject area were defined and tested as part of the thesis case study. Following validation, the subject areas were then abstracted to form the Patient Journey Modeling Meta-Methodology.
The Patient Journey Modeling Meta-Methodology (PJM$^3$) provides a solution to research hypotheses 1 and 2 from the first Chapter. Specifically it provides a generic framework that outlines the key components required to support safe, high quality patient journey improvements, including strategy and process definition, workflow support and performance measurement and evaluation criteria. Key contributions also include an architectural design that accommodates the specificities and complexities associated with healthcare redesign in particular the inclusion of patient needs and practice guidelines.

The chapter begins with an outline of the PJM$^3$ architecture and then goes on to more fully describe each of the architectural components. The inter-relationships of the components to the actual processes involved with the patient journey are discussed. A description of the flow of information supporting the meta-methodology is presented and the underlying role of information technology support within the meta-methodology is positioned.

4.2 Background

As outlined in Chapter 2, the present process modeling methods being used to model a patient’s journey and redesign the associated processes do not support all of the requirements of healthcare improvement projects. In many cases healthcare improvement projects are using the business, manufacturing and computing process redesign approaches as they were originally proposed (Young et al. 2004; Bassham 2005; Ben-Tovim 2005; IHI 2005; UK Department of Health 2005) and they are faced with being unable to capture all of the design features required to ensure a quality healthcare journey.

This has led to one-off internal enhancements to particular techniques (ARCHI Net News 2004; Bassham 2005; Bolch 2005; Australian Resource Centre for Healthcare Innovation 2006) and these enhancements are not being proliferated throughout the industry. This will ultimately lead to a miscellany of non-standardised design and process modeling techniques being used, potentially inhibiting the promulgation of new and improved patient journeys across the Healthcare domain.
Williams (2000) suggests that methodological deficiencies—particularly in regard to the capture of complex process logic and dynamics—are major obstacles for successful reengineering of business processes. Such complexities and dynamism are at the very core of healthcare improvement and thus it is not surprising that not all improvement projects are performing as expected. The large variety of process modeling approaches can cause some confusion for the inexperienced process redesigner. Such a range of approaches has evolved due to the purpose for which the final models are intended and the subject domain (manufacturing, computing etc.) for which the models are developed.

In addition Coiera (2003) states that:

_There is no such thing as a truly general purpose model and no one model is the most ‘correct’. Models are simply better or worse suited to accomplishing a particular task._ (p.6)

This aligns with the general consensus in the research community that there is a need to:

_reconcile different approaches, identify commonalities and consolidate various modeling methodologies and frameworks_ (Williams 2000, p.1).

The purpose of the PJM³ is two-fold. Primarily the meta-methodology provides an improvement architecture to support the development of new healthcare specific process redesign tools and techniques. In addition, the architecture also serves as a benchmark for identifying deficiencies of existing non-healthcare domain process redesign methods so that they can be enhanced to better support process redesign within a healthcare environment. By incorporating the specific design features of the meta-methodology into both new and existing process modeling techniques, healthcare improvement efforts will better align with the IOM’s Aims for Improvement.
Specifically patient journeys will be produced that:

- Reduce the variability of the care process thus increasing patient safety
- Are more effective and efficient
- Are patient-centered and more equitable
- Improve the timeliness of service delivery
- Incorporate the multiple contributing dimensions involved in high quality service delivery
- Are more intuitive to develop and enhance
- Improve the overall quality of the patient’s outcomes and experience.

The *Meta-Methodology* also provides a foundation for discussion and comparison of patient journey modeling initiatives across the healthcare domain and thus supports the reuse of patient journey models across similar patient flows. This is possible by using $PJM^3$ as the basis for the development of a ‘healthcare process modeling’ assessment framework. Such a framework is detailed in Chapter 5 and is used to assess the level of healthcare redesign support provided by the four process modeling techniques discussed in Chapter 2 and to suggest enhancements to those tools.

This allows healthcare improvement managers to understand the limitations of the tools they are using so that contingencies can be developed or new tools sourced thus further supporting research hypothesis 3.
4.3 Patient Journey Modeling Meta-Methodology (PJM³)

Primarily healthcare improvement is about redesigning processes and improving safety and services although one cannot be achieved at the expense of the other. This involves defining clear outcomes, connecting the processes and systems that produce the required result and maintaining the improvement through integration with other operational activities and development of a culture of continuous process improvement (Berwick 1996; Batalden and Splaine 2002).

Such an approach requires an architecture that not only addresses process improvement but that is also cognisant of the multiple dimensions contributing to the development of high-quality patient-centered journeys.

Figure 4.1 presents such an improvement architecture, in the form of a Patient Journey Modeling Meta-Methodology (PJM³).

PJM³ draws on aspects of a number of methodologies from other research domains including Business Strategy Management, Process Reengineering, Workflow Management and Decision Support Systems. It also includes additional facets from the Socio/cultural, Integrated Sciences and Clinical Guidelines arenas. The amalgamation of such complimentary components leads to the creation of an original healthcare domain specific patient journey modeling meta-method. Development of this meta-method serves two key purposes:

1. To provide the foundation for the development of a healthcare domain specific patient journey modeling tool (as detailed in Chapter 7); and
2. To provide a basis for evaluation and comparison of existing process reengineering methods that are already being used to develop patient journey models (such as those discussed in Chapters 2 and 5).

Each purpose is intent on providing a more comprehensive picture of the patient’s journey from not only the patient’s perspective but also from a management, clinician and carer perspective as well. Inclusion of the meta-method components will also address the 6 ‘Aims for Improvement’ as detailed by the IOM’s ‘Crossing the Quality Chasm’ report. This will ultimately lead to safer and higher quality models of care being delivered across the healthcare domain.
Figure 4.1. The Patient Journey Modeling Meta-Methodology (PJM)
Components within the meta-method are differentiated by colour as defined in the legend. *Patient/External Interfaces* are shown in dark green and indicate where input from patients, the community and environment should be included. Activities that relate to the development of the *patient journey models* are shown in red and depict components that are central to the outcomes of the redesign project. *System Support* is shown in blue and indicates where automated technology support should be considered or integration of manual and automated procedures can provide support. *Continuous Process Improvement* feedback loops are highlighted in purple. Finally *Information Flows* such as *Provider Strategy* and *Practice Guidelines* are depicted in black with the flow of information indicated by a directional arrow head. The Providers *Organisational Structure* provides the underlying foundation for definition of responsibility for all resources and the organisation’s reporting structure.

Attention is firstly focused on ensuring that the *Healthcare Provider’s Strategy* is clearly defined and understood by affected parties. Relevant *Government legislation, Accreditation Requirements and Provider Policy* provide input to the definition of strategic objectives and governance goals. Strategic objective definitions in the form of *Balanced Scorecard Objectives* are output to the patient journey modeling component. The meta-method considers the *patient’s needs* as an essential component through the inclusion of environmental and socio/cultural needs analysis. These provide input to both the development of the *Healthcare Provider Strategy* and the operational definition of the processes involved in the *Patient Journey*. *Practice Guidelines* are also a vital input to the development of the patient journey model. A key aspect of this component is the inclusion of evidence-based best practice. The creation of the *Patient Journey Model* is central to the overall method with model outputs being applied to new *workflow* definitions and requirements for *Decision Support Systems* for both clinical and managerial support. Clinical support deals with decisions relating to patient care and management support deals with variance analysis of resource performance. Treatment guidelines to be followed as part of workflow enactment are also passed to the workflow component. Feedback loops to both the *Healthcare Provider Strategy* and the patient journey model definition exist to provide a mechanism for *continuous process improvement*. 
All meta-methodology components and activities must also be cognisant of the organisational structure so that relevant responsibilities and cross-checks can be applied to redesigned outcomes.

The Meta-Methodology and Multi-Dimensional Patient Journey Modeling Conceptual Design (discussed in chapter 6) provide the foundation for the development of the new Patient Journey Modeling technique (PaJMa) as described in Chapter 7. Through the definition of ‘multiple dimensions’, the Patient Journey Models developed will better represent the complex stakeholder interactions and clinical streams that occur within Healthcare. This will lead to more comprehensive, robust and specific models that will increase patient safety, reduce process variability and be reusable across clinical environments. Inclusion of IT support, in the form of automated workflows and Decision Support Systems, will also provide increased efficiencies and allow feedback loops to be established so that continuous quality improvement becomes part of daily operational activities.

The remainder of this chapter will detail the definition, purpose, inter-relationships and inputs and outputs of each of the $PJM^3$ components. It will begin with two key components; namely Government Legislation/Accreditation/Provider Policy and Patient Needs. These two components are central drivers of the overall process and underpin all patient journey model activities.

### 4.3.1 Government Legislation/Accreditation/Provider Policy

All Healthcare Providers are governed by a variety of policies, accreditation requirements, guidelines and legislation. These include legal requirements and policies for patient administration. As part of the Healthcare Provider Strategy review, all relevant documentation must be taken into consideration including:

- Local, State and Federal Government legislation
- Accreditation Standards
- Hospital/Provider Policies
The Australian Commission on the Safety and Quality in Healthcare (ACSQHC) is the leading body for the setting of benchmarks for improving healthcare within Australia. The Commission has been funded by the Australian, State and Territory Governments to develop a national strategic framework and associated work program that will guide its efforts in improving safety and quality across the healthcare system in Australia (Australian Commission on Safety and Quality in Health Care 2006). Examples of legislation/accreditation standards/provider policies include items such as Domestic Violence Screening Legislation, the Evaluation and Quality Improvement Program (EQuIP) administered by the Australian Council on Healthcare Standards and individual Hospital Admissions Policy. The Joint Commission for the Accreditation of Healthcare Organisations (JCAHO) is the U.S. equivalent of the ACSQHC (JCAHO 2006). Since 2004, all U.S. hospitals have been required to select 3 core measure sets from a standard list and to track specific clinical steps or processes to demonstrate compliance and maintain accreditation (Jensen et al. 2006).

Figure 4.2 depicts the relationship of the Healthcare Provider Strategy to Government Legislation/Accreditation/Provider Policy components. These items may affect the strategy the Healthcare Organisation (HCO) can set and will have an impact on the objectives and measurements that are derived from the HCO strategy. The performance targets that are set as a result of reviewing these items may be defined by the Provider board or as directed by law.

A review of these items will lead to the setting of specific Provider objectives. These will become part of the strategy and will result in explicit Balanced Scorecard objectives and associated targets being set. These are a key input to the development of the future patient journey model.
4.3.2 Patient Needs

\( PJM^3 \) uses a patient-centered approach and as such the inclusion of patient needs are central to the success of patient journey improvements. The term Patient Needs incorporates the social, economic, cultural and demographic needs of patients as they journey through the system. Patient Needs are derived from analysis of the social demographics and cultural environment of the Provider’s community and related operating environment.

With Australia and other parts of the world becoming more culturally diverse, healthcare systems and providers need to respond to patients’ varied perspectives, values, and behaviors about health and well-being. Failure to understand and manage social and cultural differences may have significant health consequences for minority groups in particular (Berwick 1996; Donini-Lenhoff and Hedrick 2000; Betancourt et al. 2002; JCAHO 2006).

Culture has been defined as an integrated pattern of learned beliefs and behaviours that can be shared among groups. It includes thoughts, styles of communicating, ways of interacting, views on roles and relationships, values, practices, and customs (Donini-Lenhoff and Hedrick 2000). Culture is shaped by multiple influences, including race, ethnicity, nationality, language, and gender, but it also extends to socioeconomic status, physical and mental ability, sexual orientation, and occupation, among other factors. These influences can collectively be described as “socio/cultural factors,” which shape our values, form our belief systems, and motivate our behaviors. Irrespective of a person’s socio/cultural factors each and every patient is entitled to a feeling of cultural safety throughout their period of care.

The term ‘Cultural Competence’ in health care describes the ability of systems to provide care to patients with diverse values, beliefs and behaviors, including tailoring delivery to meet patients’ social, cultural, and linguistic needs. The provision of culturally competent care increases access to quality care for all patient populations and can act as a business strategy to attract new patients and increase market share (Betancourt et al. 2002).
The JCAHO supports culturally safe and competent care as part of the accreditation process via the publication of their ‘Requirements Related to the Provision of Culturally and Linguistically Appropriate Health Care’ standards and elements of performance (JCAHO 2005).

Initiatives such as community assessments, development of community and patient feedback mechanisms, multi-lingual education, support and advice, quality measures for diverse populations and hiring of physicians ‘native’ to the local population, lead to the provision of culturally appropriate care models. Such an approach leads to systemic social and cultural competence within the healthcare provider structure.

Carr’s Integrated Sciences Model (1999) suggested that a patient is a complex, but integrated system of many variables that can be categorised under five (5) broad areas: biological, behavioural, cognitive, sociocultural and environmental. The variables within each domain are constantly interacting with variables in all other domains such that a change in one effects a change in all others. Therefore to reduce stress across all 5 areas and thus stress to the patient, patient care must strive to maintain a balance between the variables at all times (Sahler and Carr 2003). This indicates that high quality clinical care alone will not provide the patient with total satisfaction.
The Meta-methodology supports a culturally competent approach by including an explicit component relating to the analysis, definition and input of patient needs to the Healthcare Provider Strategy and at an operational level, the Patient Journey Model (see Figure 4.4).

High level socio-cultural needs of the target patient population provide input into the Healthcare Provider Strategy development activity and then flow onto definition of objectives in the Patient Satisfaction Perspective of the Balanced Scorecards. These objectives are used to derive target measurements for patient journey enactment. Operational patient needs, relating to the actual models of care to be delivered, are input to the patient journey model analysis and design activities. Patient needs input may be in the form of patient satisfaction survey results, community reports, academic research articles and/or personal representations from patients or patient groups. Inclusion in the redesign team, of physicians ‘native’ to the local patient population also provides an excellent insight when developing culturally appropriate models of care (Silow-Carroll et al. 2006).
Governance of different aspects of culturally competent models of care may rest with a variety of areas within the Provider’s organisational structure and these must be defined as part of the patient needs analysis and future patient journey model development.

### 4.3.3 Healthcare Provider Strategy

To ensure that the healthcare redesign activities have a solid direction and purpose, the strategy of the healthcare provider must be documented and well understood by management and the redesign team. As a first step the vision, mission and strategy of the healthcare provider must be interrogated to determine the direction the Health Care Organisation (HCO) has laid down for its ongoing success.

It may be possible that the HCO’s mission, strategy and vision are not clearly documented or understood. In today’s highly competitive healthcare domain, clearly visible financial targets are standard practice but what may not be as standard are succinct targets for patient needs satisfaction, adherence to clinical guidelines and organisation-wide quality improvement programs. This situation will necessitate an additional exercise to clarify the strategy, with particular attention given to how the HCO sees itself being positioned in the future. This will include what clinical areas the HCO wants to specialise in and what areas it wishes to target as key service provisions.

#### 4.3.3.1 Inputs

Inputs to the development of the Healthcare Provider Strategy (see Figure 4.5) include Government Legislation, Accreditation and Provider Policy and Patient Needs. Underlying this is the organisational structure.

- *Government legislation, accreditation and provider policy* set primary benchmarks for service governance. Government legislation may come from many levels, as in Australia, where there is Local, State and Federal law to consider. Strategic guidelines may also be developed as part of accreditation requirements set by areas such as the Australian Commission on the Safety and Quality in Healthcare (Australian Commission on Safety and Quality in Health Care 2006) or The Joint Commission for Accreditation of Healthcare
Organisations (JCAHO 2005). Provider Policy may also be multi-level as it can be set for an individual organisation, a complete supply chain or a Provider group such as Mayne Health or Blue Cross.

An example from the case study is the ‘National Midwifery Guidelines for Consultation and Referral which covers all Australian States.

- Patient Needs can be derived from patient satisfaction surveys and socio/economic and cultural needs analysis of the population the Provider wishes to serve as discussed in the previous section.

\[\text{Figure 4.5. Healthcare Provider Strategy - Inputs}\]

Each of these components provides direct input to the strategy analysis activity and it is only through their inclusion that a comprehensive Healthcare Provider Strategy can be defined.

\(PJM^3\) supports the definition of the Health Care Provider Strategy through the use of Balanced Scorecards. As discussed in Chapter 2, the Balanced Scorecard (BSC) is an instrument that translates the mission and strategy of an organisation into a broad collection of action metrics and indicators that subsequently provide the structure
necessary to serve as a control and strategic measurement system (Kaplan and Norton 1992; Kaplan and Norton 1996).

Once the strategy is clearly defined and understood, strategic objectives can be set. Strategic objectives are high level goals and measurements that will ultimately be further dissected at the operational level. The Ontario Hospital Association Balanced Scorecards as adapted from Kaplan and Norton’s original Balanced Scorecard approach is the vehicle for the definition of the HCO’s strategic objectives and measurement targets within $PJM^3$ and it is the ongoing monitoring and control of these targets that will determine the level of adherence to the organisation’s overall direction and strategy.

More explicitly an objective is a statement of strategic intent. An objective states how a strategy will be made operational. Generally, the objectives form the building blocks for the overall strategy of the organisation. A measure is a performance metric that will reflect progress against an objective. A measure must be quantifiable. The measures communicate the specific behavior required to achieve the objective and become the actionable statement of how the strategic objective will be accomplished. A target is a quantifiable goal for each measure. Targets create opportunity to succeed, help the organisation monitor progress toward strategic goals, and communicate expectations. Initiatives are those action programs that drive strategic performance. These are the activities that groups will focus on to ensure attainment of strategic results. All initiatives underway in an organisation should be aligned with the strategy in the Balanced Scorecard. An initiative should be explicitly linked or mapped to achieving one or more strategic objective (Balanced Scorecard Collaborative 2000).

In short Balanced Scorecards define the knowledge, skills and systems that employees will need (system integration and change perspective) to innovate and build the correct strategic capability and efficiency mix (the clinical utilisation and outcomes perspective) to deliver specific value to the selected market (the patient satisfaction perspective) that will eventually lead to improved stakeholder value (the financial perspective) (Ontario Hospital Association 1999; Inamdar and Kaplan 2002).
In the complex environment of healthcare reporting, alignment of operational activities and measurements to the strategic direction of the organisation is critical. When structures, processes and culture aren't closely and carefully aligned with strategy, the organisation almost invariably suffers.

The primary contributor to process improvement success is active, strong and visible executive sponsorship throughout the project (Kotter 1996; Change Management Learning Centre 2005). Such support will not be forthcoming if the goals of the redesigning care project do not align with the HCO vision and strategy. Failure to align redesign activities to the HCO strategy will also severely weaken the justification for change and ongoing support for process improvements.

Some of the strategic objectives developed will be dictated by relevant professional standards and accreditation requirements and some will be specific to the socio-cultural needs of the affected patient population, the individual Area health service and government bodies at the State and Federal levels.

4.3.3.2 Outputs
Once the definitions of the Provider BSC perspectives and measurements have been finalised, the resulting objective measurement standards are integrated into the patient journey modeling analysis and design activities. As discussed in Chapter 3 within this research this is facilitated through the use of the Balanced Scorecard Collaborative BSC XML standard (Balanced Scorecard Collaborative 2001).

Selection of certain strategies (including decisions regarding accreditation) may dictate how certain treatments will be delivered. To facilitate adherence to such programs the Healthcare Provider Strategy provides output to the Practice Guidelines component in the form of compliance requirements.

The relationship of the Healthcare Provider Strategy outputs to other meta-methodology components is shown in Figure 4.6.
4.3.3.3 Feedback Loop

McGregor (2002) and Urrutia and Eriksen (2005) recognised that variances highlighted during the measurement activity should be fed back into the Healthcare Provider Strategy, as a means of identifying new measurements and further refinement of existing indicators.

Inclusions of feedback loops to facilitate continuous process improvement are also supported by the Joint Commission on Accreditation of Healthcare Organisations (JCAHO). As part of the enhanced JCAHO accreditation procedures, there is a strong focus on ‘continuous operational improvement in support of safe, high quality care’ (JCAHO 2005).

Such a ‘double-learning’ loop is critical to the development of a culture of continuous improvement at all levels of the organisation (Voelker et al. 2001) and is a key consideration in the development of the meta-methodology (see Figure 4.7).
**Figure 4.7. Feedback Loop to Healthcare Provider Strategy**

$PJM^3$ encourages a culture of continuous improvement by sending feedback from the Management Decision Support System (MDSS) to the *Healthcare Provider Strategy* component. Following workflow enactment, *actual* patient journey metrics are fed to the MDSS for comparison to *target* performance indicators. Variances are highlighted and where a BSC is impacted, feedback is sent to the *Healthcare Provider Strategy*. This may be in the form of a simple report to the Executive or where the BSC are captured in an information system by way of XML for further automated impact analysis.

### 4.3.4 Practice Guidelines

*Practice Guidelines* refer to a broad range of literature relating to the delivery of low-variability, high quality and reliable care such as clinical practice guidelines, care pathways and evidence based best practice. These may be published by medical governance bodies, professional accreditation organisations, individual or teams of clinicians, researchers and other healthcare institutions. Healthcare administrators believe that using clinical practice parameters improves health care delivery and management in a number of areas (Merritt *et al.* 1999).

*Practice Guidelines* are suggested as a way to reduce medical practice variation, enhance quality of care and contain costs of care. Having a clinical road map that
guides clinical decision making, thus minimising variation in treatment for `standard' patients, should result in improved outcomes assuming the treatment `standardised' by the guideline has been subjected to clinical trials demonstrating superior outcomes. Health care administrators and insurers have also promoted guidelines as a means to reduce the possibility of malpractice claims against clinicians and providers (Merritt et al. 1999; Leeder and Rychetnik 2001; National Electronic Decision Support Taskforce. 2002).

A key area for the identification of practice guidelines is ‘evidence-based best practice’ or ‘evidence based medicine’ (EBM). An editorial in the British Medical Journal (Sackett et al. 1996) defines EBM as:

*The conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients (p.1).*

The practice of EBM means integrating *individual clinical expertise* with the best available *external clinical evidence* from systematic research. *Individual clinical expertise* is the proficiency and judgement that individual clinicians acquire through clinical experience and practice.

*External clinical evidence* involves clinically relevant research relating to the improvement of the diagnosis, treatment and outcomes for a given condition. The main aim of external clinical evidence is to invalidate previously accepted diagnostic treatments and replace them with newer treatments that are more powerful, more accurate, more efficient and safer (Sackett et al. 1996). Originally designed to improve the quality of medical education, EBM is now mainstream in many Healthcare Organisations (HCOs).

Some argue that EBM can inform, but never replace, individual clinical expertise, as it is the clinician’s expertise that decides whether the external evidence applies to the individual patient in question, and if so, how it should be integrated into a clinical decision (Farquhar et al. 2002). Notwithstanding this viewpoint, many insurers and providers are moving to implement EBM practices in a bid to increase the reliability of care, improve patient safety and reduce the opportunities for allegations of malpractice.
As discussed in Chapter 2, two key programs using EBM to reduce variability and increase patient safety are the Institute of Healthcare Improvement’s ‘100,000’ and ‘5 Million Lives Campaigns’ (IHI 2004; 2006). Both of these campaigns ask hospitals to introduce a number of standardised care improvements for the purposes of reducing the incidents of medical harm thus saving lives. My research deals with improving the system of care which encompasses many aspects including reducing variability through the application of evidence best practise (Leape et al. 2002). 

PJM³ facilitates this by taking into account Government Legislation/Accreditation Standards/Provider Policies when formulating the Healthcare Provider Strategy and provision of an explicit link between the Healthcare Provider Strategy, Practice Guidelines and the Patient Journey Model.

National bodies such as the Australian Council on Healthcare Standards and The Joint Commission are most commonly the central source of standardised practice guidelines typically for the purposes of Provider accreditation (ACHS 1996; JCAHO 2005).
Figure 4.8 highlights the relationship of *Practice Guidelines* to both the *Healthcare Provider Strategy* and the development of *Patient Journey Models*. Strategy related to the granting of accreditation by the relevant HCO’s governing body and ongoing compliance to the accreditation program is a key area to the input of *Practice Guidelines*. Although different countries have differing accreditation programs each have a strong focus on the provision of clinically proven and safe care. Compliance to relevant legislation and Provider policy also provide key inputs. Such objectives form a sound basis for the derivation of operational measurement targets as part of the analysis and development of the patient journey models. At a lower level of abstraction *Practice Guidelines* in the form of specific treatment guidelines also provide input to the actual processes that should be conducted as part of a particular patient journey. *Practice Guidelines* also promote efficient allocation of resources and better overall delivery systems as part of the patient journey redesign (Farquhar et al. 2002).

To overcome the bias of an individual clinician’s practices, a number of experienced clinicians from within the affected clinical area should be included in the redesign team. In this way even though an individual may work slightly differently with a given guideline, consensus on an agreed modus operandi can be reached and used when designing the new patient journey. This ‘team’ approach also helps to ensure clinician ‘buy-in’ for the implementation of the new procedures.

Ensuring compliance to *Practice Guidelines* may currently rest with a variety of different areas within the HCO’s organisational structure. Ideally as part of the new patient journey design, responsibility for a given practice guideline should be assigned to a single primary stakeholder. Although this may not be possible when a patient journey transverses multiple departments or providers, the number of positions sharing responsibility must be minimised. This negates the possibility of ‘handing-off’ responsibility when problems or errors arise.
4.3.5 Patient Journey Model Definition

The primary focus of the new meta-methodology ($PJM^3$) is the facilitation of the development of high-quality patient-centered patient journey models that lead to reduced care variations and increased patient safety. It allows for the analysis of the current patient journey and the improved future patient journey using the same artifacts and input and outputs.

Definition of the Patient Journey Model can be performed using a variety of process modeling techniques from the Process Reengineering domain. Chapter 5 discusses the process modeling techniques most commonly used within the Healthcare domain and evaluates them for their support of process improvement in healthcare. Chapter 7 presents a new Patient Journey Modeling technique known as $PaJMa$.

4.3.5.1 Inputs

Development of Patient Journey Models (PJM) should be conducted by a team of stakeholders, involved in the actual delivery of care, for the journey under review. This team includes members from all levels of the organisation such as clinicians and other health workers, clerical and lab staff, management, IT support, patient representatives and if applicable external suppliers such as paramedics or GPs. Collectively these stakeholders make up the redesign team.

In the first instance a model of the current patient journey is developed. This deals exclusively with the processes, people and systems involved in the ‘as-is’ journey and leads to the identification of problem areas that will become targets for improvement in the development of the future patient journey. Development of patient journey models involves face-to-face sessions with members of the redesign team. These face-to-face sessions should be led by an experienced facilitator whose role it is to guide the process and structure of the sessions whilst encouraging the participants to share their knowledge and expertise to arrive at an accurate picture of the present situation - the current patient journey. The aims of such facilitated workgroups are to achieve a shared understanding of the issues facing the group, a sense of common purpose and a mutual commitment to action (Phillips and Phillips 1993).
Inputs to the PJM include strategic objectives in the form of BSC perspectives, operational level treatment guidelines and specific patient needs, as shown in Figure 4.9.

Both the Current and Future Patient Journey Models (PJM) are developed from the viewpoint of the patient as opposed to the healthcare organisation or clinician. The current patient journey maps the care processes – ‘warts and all’ and must be an ‘uncensored’ and accurate representation of what actually goes on ‘right now’. No attempts should be made to improve anything in the first instance and if critical issues are uncovered this is a positive, not a negative outcome of the redesign exercise.

It is possible that disagreements may arise as people outline how they think things work today and as others enlighten them as to how they really do work. This is in fact constructive and allows both good and bad aspects of the journey to be bought out as well as creating a shared knowledge of how each area interacts and is affected by another. The resulting model (the current patient journey) is an end-to-end process map of the patient’s experience for a given service including the various dimensions that contribute to the journey such as staff involved, information captured and transferred, guidelines followed and metrics to be captured.
Once complete the current PJM is interrogated for improvement opportunities. Areas such as information duplication, excessive patient movement or care handovers, unsafe procedures or non-compliance to set guidelines are key targets. Some of these may be very obvious and will have surfaced during current PJM model development. Others will be more subtle and may require some in depth analysis. Improvement targets are simply highlighted on the model itself and form the starting point for the development of the improved or ‘future’ patient journey.

The purpose of the future PJM is to develop a comprehensive and accurate picture of how the ‘ideal’ journey, once improved, will be enacted and how improvements will be evaluated. The future PJM is developed using exactly the same inputs as the current PJM. Additional activities may be required however to more clearly define or enhance existing Healthcare Provider Strategy and objectives and to identify patient needs relevant to the local population. A decision may also need to be made regarding the implementation time frame of future PJM iterations. For example, the redesign team may highlight that there is a need for a new (or integrated) information system that is used as a single point of data capture. Depending on the development backlog of the IT section this may take a good deal of time and therefore other interim processes may need to be considered to overcome the problem in the short term. In this way there may be several iterations of the future PJM, each introducing increased improvements to the patient journey over time until the ‘ideal’ journey is reached. This is similar to the Model For Improvement’s PDSA cycles (IHI 2003). Possible time frames are immediate, short (within 4 weeks), medium (within 3 months) and long (within 6 months). Irrespective of how many implementation iterations may be necessary, the ‘ideal’ future patient journey model must always be developed in full as a starting point. This is then used as the benchmark against which all improvements can be assessed.

Input of BSC objectives to the future PJM is facilitated via the use of the Balanced Scorecard Collaborative’s BSC XML standard (Balanced Scorecard Collaborative 2001) The BSC objectives drive the definition of operational measurements for specific processes enacted as part of the journey.
For example

A Clinical Utilisation and Outcomes Perspective objective at the strategic level may state that the HCO ‘will pursue and attain accreditation from the JCAHO within the next 12 months’. One aspect of the operational targets at the patient journey level can then focus on the definition of processes that facilitate targets relating to the compliance to clinical practice guidelines as published by the JCAHO accreditation board, for relevant patient journey processes (i.e. ‘preventing ventilator-associated pneumonia by following 4 steps including raising the patient’s bedhead’) (Berwick et al. 2006). It must be noted that all operational measurements defined as part of the patient journey model must be able to be linked back to a strategic objective or the value of the work being conducted must be questioned.

This example also provides an illustration of the role of practice guidelines as an input into the definition of the future PJM. As part of the definition of each process within the journey, specific practice guidelines, that must be included as a part of the process enactment, are detailed along with adherence measurements and patient safety improvement targets. The ideal approach is to develop XML schemas or ontologies to define practice guidelines to enable explicit links to the PJM. Aspects of the HL7 Reference Information Model (RIM) also provide standards for the transmission of relevant messages in relation to procedures to be delivered.

Patient Needs inputs incorporate the social, economic, cultural and demographic needs of patients as they journey through the system. Patient Needs are derived from analysis of the social demographics and cultural environment of the Provider’s community and related operating environment via socio/cultural needs analysis or similar as discussed in section 4.3.2. At an operational level items such as appropriateness of environment, inclusion of ‘native’ staff resources and patient education are key target areas for improvement. However other more personal areas must also be considered such as end-of-life care and birth rituals. Ideally input should come from patient’s who have recently undergone this patient journey and members of the community who can represent cultural patient needs. Future patient journey models must ensure culturally safe and competent care environments. Input of patient needs to the Future PJM may be in the form of XML schemas or specific
metrics that will be used to measure the quality of patient journey post-implementation.

Responsibility for the new patient journey should ideally rest with one position within the HCO’s organisational structure. If this is not plausible then each process must be assigned an ‘owner’ whose role it will be to ensure all resources comply with the process requirements and to liaise with other process owners if issues arise. This will entail deciding whether the process should be changed or whether associated inputs and/or outputs will need to be altered. The performance of a process owner, will in part, be measured by the increased quality outcomes of the processes under their control.

4.3.5.2 Outputs

The process definitions resulting from the development of the future PJM are fed into the Workflow component. New workflows may take the form of improved manual procedures or systems automation. The decision on what processes will be manual and which will be automated will depend on issues such as available budget and IT development backlogs.

Figure 4.10. Patient Journey Model Outputs
Within this research, process definitions for automated processes are developed using the Work Flow Management Coalition’s (WfMC) XML Process Definition Language (XPDL) (WfMC 2005). If a variety of process improvements are possible, definition as XPDL also facilitates input of process definitions into an XML compatible simulation engine to enable simulation of the model. It must be noted however that simulation model concepts and semantics as they relate to PJM improvements are out of the scope of this research.

Process definitions and metrics in the form of measurement criteria and target values are also fed into the design of the Management Decision Support System (MDSS). These form the basis of the data structures that will be used for performance analysis and identification of variances and what-if analysis - post workflow enactment. Requirements for automation of treatment guidelines in the form of a Clinical Decision Support System (CDSS) are also output from the patient journey model activity and will be referenced during performance of the patient journey workflows.

4.3.5.3 Feedback Loop
Following workflow enactment, actual patient journey measurements are sent to the Decision Support System component, specifically to the Management Decision Support System (MDSS). These actual measurements are then compared with the expected target measurements that were sent to the MDSS as an output of the future PJM development (see Figure 4.10). Variances are analysed by management who decide if the PJM requires further enhancement or alternatively if the metric definition, capture and analysis activities need revision. This results in a feedback loop to the PJM that facilitates on-going learning and continuous process improvement as shown in Figure 4.11.
Chapter 7 presents a new and innovative patient journey modeling tool designed specifically for the healthcare domain. An original Systems Development Life Cycle (SDLC) detailing in full how PJM projects are conducted can be found in Curry et al. (2007). The work discussed in this paper was developed as part of the conduct of the research case study described in Chapter 5.

4.3.6 Workflow Enactment
The process definitions received from the Patient Journey Model Definition stage are analysed to determine the actual degree of workflow automation that is available/possible. Workflow enactment may actually be a combination of manual and automated processes but both are driven by the process definitions output from PJM redesign activities.

4.3.6.1 Inputs
Definitions of the processes within the future PJM, that will be automated, are developed using the WfMC XML Process Definition Language (XPDL) (WfMC 2005). This will include allocation of role responsibility for individual processes as defined by the organisational structure.
During workflow enactment of the redesigned patient journey, workflow activities may require input from relevant Clinical Decision Support Systems (CDSS). This provides support to frontline healthcare workers in the diagnosis and treatment of patients. Input may come from existing CDSSs or a CDSS that has been newly developed as part of the future patient journey model design. The guidelines referenced by the workflow activities would be in the form of a computer interpretable guideline language such as Arden syntax, GLIF or PROforma as an example (Coiera 2003).

4.3.6.2 Outputs
Following enactment of the workflows actual measurement values are sent to a Management Decision Support System (MDSS) for use in performance analysis and identification of variances. This aspect of the method applies McGregor’s (2002) basic Intelligent Workflow Monitoring System (IW-MONS) methodology into the Healthcare domain.

By providing management with facilities to compare target to actual performance measures, resource utilisation can be monitored and compared to plan. Variations can be highlighted and ‘what-if’ analysis conducted to determine the most appropriate method for bringing ‘out-of-order’ metrics back into line. This also facilitates Berwick’s (1994) requirement for a ‘learning’ organisation.

The relationship of Workflow systems to other meta-methodology components can be seen in Figure 4.12.
4.3.7 Decision Support

The $\text{PJM}^3$ Decision Support System component supports decisions in two key areas: Clinical Decision Support (CDSS) and Management Decision Support (MDSS). This relationship accommodates an explicit link from the Practice Guidelines and Healthcare Provider Strategy components through the Patient Journey Model definition to the Decision Support System component ensuring that practice guidelines and performance measurement to set targets can be monitored and interrogated for variances.
4.3.7.1 Inputs

\( PJM^3 \) allows for proven clinical knowledge such as evidence-based best practice to be linked to specific processes in the patient journey model and requirements for related system support to be fed to the Decision Support System component (see Figure 4.13). The Decision Support System Component then provides Clinical Decision Support System (CDSS) input to the workflow component as part of workflow enactment, as needed.

Using the same logic, performance measurement criteria relating to BSC’s and operational resource utilisation can also be detailed as part of the patient journey model with target process metrics sent to the Decision Support component for use by the Management Decision Support System (MDSS). The redesigned future PJM process definitions are used as input during the construction of the MDSS and to identify target measurement criteria for ongoing variance analysis activities. The target measurement values for processes within the Patient Journey are stored for post-workflow enactment interrogation.
Once the workflows are enacted actual process metrics are received from the Workflow activity and compared with the target metrics. Where variances are discovered further analysis can be conducted and decisions made on action to be taken. Such action may include further PJM enhancements, modification of metrics being captured and/or changes to aspects of the Healthcare Provider Strategy.

In PJM$^3$ the process definitions will be handled by using the Workflow Management Coalition’s XML Process Definition Language (XPDL) (WfMC 2005). This aspect of the research will uses McGregor’s (2002) IW-MONS methodology. The resulting transformation process may consist of the interpretation, analysis, manipulation and aggregation of data that occurs as performance metrics are made sense of before they are used in decision making. Where data is required to be analysed in more than one place the raw data should be transmitted intra-system via the use of XML/web services or similar (McGregor 2002).

### 4.3.7.2 Outputs
Output from the Management Decision Support System and associated variance analysis activities are interrogated to determine if further enhancements to the Healthcare Provider Strategy or the Patient Journey are required. This aspect of the method also applies McGregor’s (2002) basic Intelligent Workflow Monitoring System (IW-MONS) methodology into the Healthcare domain. Such a feedback loop facilitates continuous process improvement as discussed 4.3.8.

### 4.3.8 Continuous Process Improvement
Following workflow enactment, variance analysis and evaluation activities are conducted using Management Decision Support Systems as discussed in the previous section. Such analysis results are reviewed by management and variations may lead to an adjustment or change in the Healthcare Provider Strategy or the actual patient journey. This closed loop facilitates a culture of Continuous Process Improvement and on-going learning (Berwick 1996; Batalden and Splaine 2002). This ensures that quality improvement is ongoing and does not end after the first iteration of future patient journey model implementation. If variance analysis results do lead to Strategy adjustments, the Provider BSC’s must also be reviewed and updated.
Figure 4.14 indicates the meta-methodology’s two feedback loops for continuous process improvement.

Figure 4.14. Decision Support System Outputs Supporting Continuous Process Improvement
4.4 Conclusion

This chapter described an original healthcare domain specific improvement architecture in the form of a patient journey modeling meta-methodology known as $PJM^3$. The $PJM^3$ combines a number of complimentary method components from several other domains including Business Strategy Management, Process Reengineering, Workflow Management, Decision Support Systems, Socio/cultural, Integrated Sciences and Clinical Guidelines.

The amalgamation of a range of approaches better serves to address the IOM’s ‘Aims for Improvement’ (Committee on Quality of Health Care in America 2001) and the complexity of healthcare quality improvements in general. More explicitly it provides a solution to hypotheses 1 and 2 from Chapter 1. Specifically $PJM^3$ provides a generic framework that outlines the key components required to support safe, high quality patient journey improvements, including strategy and process definition, workflow support and performance measurement and evaluation criteria. Key contributions also include an architectural design that accommodates the nuances and complexities associated with healthcare redesign in particular the inclusion of patient needs and practice guidelines.

Chapter 5 uses $PJM^3$ as the basis for the development of a ‘healthcare process modeling’ assessment framework. The purpose of the assessment framework will be to determine the level of support provided for healthcare redesign and in particular patient journey modeling, using $PJM^3$ as the benchmark. Chapter 5 will use the thesis case study to apply the assessment framework to the four process modeling techniques/methods discussed in Chapter 2, namely; Lean Thinking, ARIS, Six Sigma and Unified Modeling Language (UML).
CHAPTER 5
A PROCESS MODELING ASSESSMENT FRAMEWORK FOR HEALTHCARE

5.1 Introduction

This chapter provides a fresh approach to assessing the level of support provided by process modeling techniques/methods for the purposes of modeling and redesigning patient journeys. The Process Modeling Assessment Framework for Healthcare, known as PMAF4HC or simply the Assessment Framework, presents a standard skeleton that can be used to evaluate any process modeling technique/method that is being considered for use within a healthcare improvement project encompassing patient journey modeling.

The main motivation for the development of the Assessment Framework lies with the fact that all patient journey improvement projects conducted to date have used ‘foreign’ process modeling techniques/methods from non-healthcare domains. When combined with the fact that only scant research has been conducted on how well these techniques accommodate the particular nuances and inherent complexities associated with the redesign of patient-centric healthcare processes, this topic remains an open research area.

Chapter 4 outlined an innovative healthcare improvement architecture in the form of a patient journey modeling meta-methodology known as PJM$. PJM$ provides the basis for the development of a healthcare process modeling Assessment Framework that serves two key functions.

1) To evaluate the degree of support afforded to healthcare process redesign projects by existing process modeling techniques/methods,
2) To provide a benchmark for the development for new patient journey modeling tools.

Development of the *Process Modeling Assessment Framework for Healthcare* provides a solution to research hypothesis 3.

This chapter begins with a brief background of the thesis case study area, a primary-care maternity service at Ryde Hospital, New South Wales, Australia. A detailed description of the current service and the associated improvement goals are included. A review of the graphical notations and method semantics used by the four process modeling techniques/methods discussed in Chapter 2 is then conducted. Subsequently each process model is used to graphically describe the patient journey associated with the midwifery case study. The *Assessment Framework* and each assessment area are outlined. The modeling techniques/methods are then evaluated using the *Framework* and strengths and weaknesses discussed. The chapter concludes with a range of suggested enhancements that each process model notation requires to improve the level of support currently provided for healthcare redesign projects involving patient journey modeling.

The selection of methods is based on the current degree of use of each method within the healthcare improvement arena and/or the relationship of the selected methods to other healthcare developments such as HL7. The methods selected are Lean Thinking, Six Sigma, ARIS and UML-Business Process Modeling Notation.
5.2 Case Study

5.2.1 Introduction
In this section the case study environment – a midwife-led primary care maternity service at a suburban Australian hospital, is described. The scope of the case study involves an assessment of the flow of a woman through the Ryde Midwifery Group Practice (RMGP) Model (Tracy 2004; Tracy and Hartz 2005). The goals and objectives of the Service are reviewed and a detailed description of the current patient journey is provided.

5.2.2 Primary Care Maternity Services Background
The thesis case study involves a primary care maternity services model delivered by certified midwives, to low risk women. The service is offered in a suburban public hospital in Ryde, New South Wales (NSW), Australia.

In the main Maternity services in Australia are currently hospital-based and provided by a range of different health professionals. Across Area Health Services there are systemic differences in style, philosophy and resource intensity of care provided by certified midwives, obstetricians and general practitioners to similar groups of women. There is a growing awareness of the need for a greater focus on equity of access to ensure that the services provided to women from marginalised groups, who have the poorest outcomes, are more appropriate and better utilised (NSW Department of Health 2000).

Some institutions offer team midwifery with differing levels of continuity of midwifery carer. A small number of midwife-led primary care models (caseload midwifery) are available in Australia but these are generally limited to rural and remote areas such as Western Australia and South Australia (Church and Nixon 2002). In other western countries, particularly in the United Kingdom, New Zealand and Canada, caseload midwifery is promoted and funded as a public health strategy (Tracy 2002). Community based care from midwives can be responsive to local needs, particularly with regard to health inequalities and social exclusion (Schmidt et al. 2002; New Zealand Health Information Service. 2003).
In NSW there have been three randomised controlled trials of continuity of midwifery care that have demonstrated a capacity to reduce costs and benefit organisations and improve the birth outcomes for women and babies (Kenny et al. 1994; Rowley et al. 1995; Homer et al. 2001; Homer et al. 2001). A recently published systematic review confirms that continuity of midwifery care when compared to standard care reduces costs and increases effectiveness of resource utilisation (Henderson et al. 2001). In addition a study undertaken on the cost of obstetric interventions in NSW (Tracy and Tracy 2003) demonstrates the escalation of costs incurred by the introduction of obstetric intervention for low risk women.

5.2.3 The Ryde Environment

Ryde Hospital is a 170 bed acute facility just under 20 kilometers from the city of Sydney. The Hospital is affiliated with the University of Sydney and provides acute medical, surgical, orthopaedic, intensive care, maternity and aged care services. There are extensive community health services including child and family health, dental health, aged care and mental health.

Just over 12 months ago the Maternity Department at Ryde hospital was thrown into crisis-mode. The one and only anesthetist had left and a replacement could not be found. The NSW government felt it had no option but to close the obstetric unit at Ryde and make the women who would normally attend Ryde’s obstetric unit travel a further 15 kilometres to Royal North Shore hospital at North Sydney. Senior management and the midwifery staff at Ryde did not feel that they could remove their services from the local community without putting them at a severe disadvantage so the staff sought to overcome the crisis through the implementation of a new approach to obstetric and midwifery care for the local area. A midwife-led primary-care service known as the Ryde Midwifery Group Practice (RMGP) Model was introduced in January 2004 (Tracy 2004). The RMGP model is specifically for identified ‘low-risk’ women and each woman must be individually assessed for her suitability for the service. Each woman is allocated to dedicated midwife, who delivers care to her allocated women throughout the pregnancy, thus providing individualized antenatal, intra-partum and postnatal care.
5.2.4 Goals and Objectives
The strategy of the Ryde Midwifery Group Practice (RMGP) Model is focused on the delivery of high quality primary-care maternity services to identified low-risk women through a public healthcare facility in a timely manner (Tracy 2004).

Rapid access and high responsiveness are among the major quality characteristics desired by patients in health care (Berwick 1994). This is achieved at Ryde by the allocation of a dedicated midwife to each woman. The woman then interacts with her single point of contact and receives personalised care from a qualified and trusted person who is aware of her personal situation and past obstetric and medical history.

Objectives relating to achievement of the RMGP strategy were discussed. These objectives related to how the redesign team saw the overall strategy being met and the realisation that such objectives were not being measured or adequately analysed in the current workflows. Documenting objectives as part of the modelling process provides a framework for assessment of the patient journey as individual instances of the process are enacted.

5.2.5 Balanced Scorecard Perspectives
As discussed in Chapters 2 and 4 this research will use the BSC perspectives as proposed by the Ontario Hospital Association (1999) namely: Patient Satisfaction, Financial Performance and Conditions, Clinical Utilisation and Outcomes, Systems Integration and Change. The service level objectives that the Ryde Midwifery Group Practice Model have chosen to measure and analyse as part of the future patient journey are depicted using these four Balanced Scorecard perspectives as follows.

5.2.5.1 Patient Satisfaction Perspective
The central questions in this perspective, “How do our customers (patients) see us?” and “How does the organisation become its targeted patients most valued supplier?” look at how the organisation is performing from the viewpoint of the patient. This perspective provides information regarding the quality of, and satisfaction with the services delivered, as well as how the health service is perceived in its community.
Specific target areas may centre on indicators for timeliness, quality of service and patient complaints.

The case study service level objectives for the Patient Satisfaction Perspective are as follows.

**PSG1:** It should take no longer than 24 hours from the time an Assessment Questionnaire is requested to the time it is dispatched.

**PSG2:** It should take no longer than 48 hours from the time of the completion of the Suitability Decision until a phone call to the woman advising her of the decision outcome is made.

**PSG3:** A Booking Interview appointment is required within two (2) weeks of making initial contact with the woman.

**PSG4:** Each woman will have the opportunity to complete a Patient satisfaction survey.

### 5.2.5.2 Financial Performance and Conditions Perspective

Describes how HCO’s manage their financial and human resources. It refers to the HCO’s financial health, efficiency, management practices and human resource allocations. The contribution to the bottom-line in the case of public hospitals relates to the containment of costs and the ability to operate within assigned budgets.

Financial Performance and Conditions Perspective goals are as follows.

**FPG1:** Ratio of staff to patients is not less than 90% of budget.

**FPG2:** Provision of services and facilities should be +/- 5% of budget.

**FPG3:** All patients accepted for care must have a valid Medicare card.

### 5.2.5.3 Clinical Utilisation and Outcomes Perspective

Information in this perspective relates to the efficiency and clinical performance of the healthcare organisation’s (HCO’s) processes, specifically relating to the delivery of the objectives as defined in the Patient Satisfaction and Financial perspectives. Refers to items such as hospital services, clinical efficiency and quality of care.

Clinical Utilisation and Outcomes Perspective goals follow.

**CUOG1:** 100% of suitability assessments will be conducted in accordance with the National Midwifery Guidelines for Consultation and Referral and the RMGP Model.

**CUOG2:** Completed Assessment Questionnaires, will be assessed within 1 working day of receipt.
CUOG3: If an Assessment passes the suitability check, it will take no longer than 1 working day to assign the patient to a nominated Caseload midwife.

CUOG4: It will take no longer than 4 hours from the time a woman is assigned to a Caseload midwife until the first attempt, to contact the woman to make a booking interview appointment, is made.

5.2.5.4 Systems Integration and Change Perspective
Describes a HCO’s ability to adapt to its changing healthcare environment and defines the core competencies and skills, the technologies and the corporate culture required to support the overall strategy. These objectives enable an organisation to align its human and IT resources with its strategy. Provides information on innovation and improvement measures for new services. Includes development of new technology support and development of staff. Systems Integration and Change Perspective objectives include:

SICG1: Provision of an online Assessment Questionnaire facility will be delivered within 9 months.

SICG2: Initial Suitability decisions will have a confidence level of at least 90%.

SICG3: Each midwife must attend 2 in-service training sessions on the National Midwifery Guidelines for Consultation and Referral and the questionnaire assessment process each year.

SICG4: Management and midwife staff will conduct bi-annual reviews of the patient journey based on feedback from the patient satisfaction surveys.

5.2.6 Structure, Roles and Staff
The organisation structure, roles and staff are as follows. There are three distinct teams within the case study area: management, clerical and administrative support and caseload midwives.

The roles within each team include:

Management – Nurse Unit Manager is responsible for ensuring all women are assigned to a midwife correctly, staff absences are covered and clinical and administrative policy are followed.

Clerical and administrative support – The Ward Clerk is responsible for completion of clerical duties including paperwork, data entry and file management.
Caseload midwives — *A primary-care midwife* is responsible for individual care of a woman during the ante-natal, intra-partum and post-partum periods.

Within organisations staff are assigned to roles. Role assignment at Ryde is as follows:

- *Nurse Unit Manager 1* is assigned the role of *Nurse Unit Manager*
- *Ward Clerk 1* is assigned the role of *Ward Clerk*
- *Caseload Midwife 1-6* are assigned the role of *Caseload Midwife*

### 5.2.7 Current Patient Journey

The current patient journey discussed below, represents the movement of a woman and the processes involved in the woman’s flow through the RMGP model up to the completion of the Booking Interview. The journey also depicts staff roles, information created and transformed, patient needs, legislation and policies involved and the metrics required to measure and assess the patient’s journey. The steps involved in the current patient journey are:

1. A *woman* phones or attends Maternity and requests to birth at Ryde
2. The *ward clerk* checks to see if the woman has a valid Medicare card, if so an appointment is made for a clerical booking. If the woman has personally attended Maternity and the ward clerk is available at the time, the clerical booking can be done straight away. If not the woman must return at another time.
3. The clerical booking takes approximately 20 minutes and uses 3 forms: U2AA, Inpatient Election and the MRN sheet. The *ward clerk* enters the relevant information into the Patient Administration System (PAS) and prints the rest of the MRN sheet and a number of patient ‘sticky’ labels. The paperwork is placed in the Bookings Folder for allocation of the woman to a caseload midwife.
4. At the next Allocation Meeting, held each Wednesday, the clerical bookings and any known previous pregnancy records for each woman are reviewed by the *Nurse Unit Manager* and the *Caseload midwifery team*. Each *woman* is then allocated to a dedicated midwife based on existing midwife workloads and specific requests of the woman (ie: she may have given birth previously at Ryde and wishes to have the same midwife).
5. The allocation information is written in 4 places. A whiteboard showing details of each caseload midwife’s current allocations and expected absences, the Bookings Book (black) kept on the ward, Bookings Folder (purple) kept in the clinic and the allocated midwife’s personal diary.

6. The woman is rung by her allocated midwife to make a Booking Interview Appointment. The appointment time is recorded in the midwife’s personal diary, the Clinic Diary and the Bookings Folder (purple).

7. The woman arrives at Ryde for her Booking Interview.

8. The woman gives/receives general information and advice about her pregnancy and is asked if she has any initial concerns. Any existing pathology reports or ultrasounds are also reviewed.

9. The RMGP model is outlined and discussed. Based on her history and this new information, the woman and midwife discuss if the Ryde model is the best option for the woman. If not, the woman is advised of other birthing options. If yes, continue.

10. If the woman continues a full medical history is collected and relevant details are entered into OBSTET and the woman’s antenatal notes are updated.

11. Following collection of a full medical history the woman’s suitability for the RMGP model is assessed. If the woman is unsuitable she is advised to book elsewhere, a referral is completed and her notes are collated. If she is assessed as suitable - continue.

12. If the woman requires referrals for pathology, Nuchal Translucency Screening or dating ultrasounds etc., these are now prepared.

13. A Domestic Violence screening is conducted. This can be delayed to the next visit under certain conditions. a) the woman is not alone (interpreter and children under 3 are permitted; b) the woman’s partner gets upset when asked to leave.

14. A physical examination of the woman is conducted. This includes blood pressure readings, fundal height palpitation and breast examination.

15. The booking is then finalised by finishing and printing OBSTET input. The midwife then makes the next antenatal appointment time and records it in the clinic diary, the midwife’s personal diary and on the woman’s Yellow Card. The woman’s antenatal notes are then collated along with the H35 and any previous medical record details. Place a sticker on the notes and file them.
5.3 Applying the Selected Process Models to the Case Study

There are a great number of process modeling methods that can be used to redesign process flows. Selection of those process modeling methods that will be applied to the case study and then assessed for their level of support for healthcare redesign is based on the degree of use within the industry. As discussed in Chapter 2 the four process modeling methods used in the evaluation are:

- Lean Thinking
- Six Sigma
- ARIS
- Unified Modeling Language (UML) – Business Process Modeling Notation (BPMN)

It should be noted that although there may be many artifacts used by the above methods during the analysis and design of process improvements, this research is primarily concerned with those artifacts used to diagrammatically represent the movement of patients across the organisation and between the organisation and its partners. This will see focus directed only towards the graphical ‘process models’ employed by the above methods and will include definition of the modeling representations and associated semantics.

5.3.1 Lean Thinking

The Lean Thinking method uses Value Stream Maps (VSM) to model the process flow for a given product or service through an organisation and its between partner organisations. The Institute of Healthcare Improvement promotes the development of value stream maps (VSM) as part of the Breakthrough Series-Model for Improvement (IHI 2003; IHI 2005) for redesigning patient flow. The Improvement Leaders Guides developed for NHS healthcare improvement projects also support VSM development when redesigning the patient journey (NHS Modernisation Agency 2005).

Examples of Lean Thinking in healthcare include (Bushell and Shelest 2002; Heyamoto 2002; Laursen 2003; Bassham 2005; IHI 2005; NHS Institute: Service Transformation Team. and University of Warwick. 2007).
5.3.1.1 Value Stream Maps

Value Stream Maps usually consist of four horizontal layers as shown in Figure 5.1 and are read left to right.

<table>
<thead>
<tr>
<th>Patient Location/Movement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staff Roles and</td>
</tr>
<tr>
<td>Information Creation/Movement</td>
</tr>
<tr>
<td>Process Flow</td>
</tr>
<tr>
<td>Process Timings</td>
</tr>
</tbody>
</table>

Figure 5.1. Lean Value Stream Map Layers

A range of icon libraries are available to represent process interactions, with healthcare specific icon libraries available in the current version (eVSMv3) (GumshoeKI Inc 2006). Icons can depict things such as people involved in processes (including staff and patients), documentation, information systems and the physical processes themselves. Icons are linked via the inclusion of directional arrows.

The time taken to complete a process or move from one process to another is known as cycle time. Cycle time has two types: Value-Added and Non-Value-Added. Value-Added cycle time refers to those activities that directly involve caring for the patient. Adversely, Non-Value-Added cycle time indicates time that does not directly contribute to patient care. An example would be waiting for a specialist consult. This can also be called ‘Queue’ time and is explicitly shown on the model. An example of the icons that may be used in each layer are shown in Figure 5.2.
Initially the scope of the value stream mapping (VSM) activity is defined. This should involve only one particular clinical treatment stream or service. Once the scope is agreed a VSM of the current state (as it stands today) is developed. It identifies key processes, information and materials (resources) that support the flow of patients within the scope boundary. Problem areas (known as kaizens) are then highlighted and potential improvements evaluated. This leads to the development of the future state value stream map of how the patient journey should look after the resulting work plan is implemented (IHI 2005).

The starting point for creating the current state value stream is the patient’s initial contact point with the healthcare service. The current state VSM ends at the patient’s point of exit from the healthcare service. Separate value streams should be developed for co-morbidities. The following three Figures depict the case study presented in section 5.2.7 as Lean Thinking Current State Value Stream Maps.
Figure 5.3 Lean Value Stream Map – RMGP Suitability Assessment - page 1

Figure 5.4 Lean Value Stream Map – RMGP Suitability Assessment - page 2
The Lean Thinking Value Stream Maps developed will be evaluated using the Assessment Framework and results discussed in Section 5.4.
5.3.2 Six Sigma
Six Sigma is a method for improving productivity and profitability and uses the disciplined application of statistical problem-solving tools to identify and quantify defects and indicate steps for improvement (Keller 2005; Brue and Howes 2006). Originally used for improving manufacturing processes, Six Sigma is now used in a wide variety of areas including services provision, business processing and healthcare. Six Sigma can be also used in conjunction with Lean Thinking as a complimentary toolset mainly to improve process measurement (George 2003; Brue 2005; iSixSigma Healthcare 2006).

Examples of Six Sigma in healthcare include (George 2003; Sehwail and DeYong 2003; Wing et al. 2005; iSixSigma Healthcare 2006).

Six Sigma in its entirety is a complex statistical improvement method. The tools used to produce process models however are very basic. The two main tools used are SIPOC diagrams and Process Maps (Keller 2005; Brue and Howes 2006).

5.3.2.1 SIPOC Diagram
SIPOC stands for suppliers-inputs-process-outputs-customers. The context or scope of the Six Sigma improvement exercise is defined using a SIPOC diagram. This involves defining the core business process/es that the project will focus on, such as:

- those that provide input to the process (suppliers)
- the resources, data and knowledge required to generate the required output (inputs)
- the activity that transforms inputs to outputs (process)
- the results of the process (outputs)
- those persons or functions that will receive the outputs (customers)  
(Keller 2005)

The central focus of this diagram is the high level functional steps involved in the delivery of the product or service.

SIPOC deliverables can be in the form of a table but are most commonly presented as a diagram and are fundamentally just a process map at a higher level of
abstraction. The five key parameters are listed across the top of the page with information relevant to the parameter, as it relates to the process under analysis, listed below it. The major process steps are shown sequentially below this information as outlined in Figure 5.6. (NB: An additional parameter can also be added called Requirements. This is used to capture specific customer requirements that arise during definition of the high-level processes. These requirements are used as one of the basis for metric development in later phases).

![Figure 5.6. Template for a High-Level SIPOC Diagram (iSix Sigma Healthcare 2005)](image)

5.3.2.2 Process Maps
Six Sigma Process Maps are based on the SIPOC diagram and follow a very similar syntax to a number of other flowchart-type techniques such as UML-BPMN (see 5.3.4). Process Maps are defined as a simple graphical tool for documenting the flow of a set of processes and identifying areas of waste (Brue and Howes 2006). They are similar to a flowchart and follow closely the semantics of traditional flowcharting. Swimlanes are also used in the diagram to represent and separate different stakeholders (Keller 2005), a reason why Process Maps are sometimes known as Swimlane models.

It should be noted however that three different diagramming representations were found in the Six Sigma resources reviewed (Brussee 2005; Keller 2005; Brue and Howes 2006). Each included or excluded particular information or presented it in a different way. This related to items such as cycle time, defects per unit and other standard or high-profile metrics as defined by the organisation. The selected
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diagramming notation is a combination of the work from Keller (2005) and Brue and Howes (2006) as this was most representative of the works reviewed. Figure 5.7 is used to clarify the nuances of the Six Sigma process map symbols.

Figure 5.7. Typical Six Sigma Process Map Symbols (Brue and Howes 2006)

The Six Sigma SIPOC diagram and Process Maps for the case study are shown in Figure 5.8 to Figure 5.10.

Figure 5.8. SIPOC Diagram of RMGP Suitability Assessment

The Process Maps for the case study use the swimlane concept to depict the different actors that participate in the patient journey, such as woman, midwife and Nurse Unit Manager (NUM). Relationships between actors are shown via the use of arrows that cross the swimlane ‘ropes’.
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Figure 5.9 Six Sigma Process Model – RMGP Suitability Assessment p.1

Figure 5.10 Six Sigma Process Model – RMGP Suitability Assessment p.2
5.3.3  ARIS
Developed by Scheer and first published in 1994 ARIS is an architectural framework for integrated information systems (Scheer 1994). ARIS is considered a leader in the business process modeling domain and released the ARIS Healthcare Solution in 2004 (IDS Scheer 2004). Purporting to be a tool customised specifically for the healthcare domain, the ARIS Healthcare Solution is based on the original ARIS business process modeling method and architecture. The major reported enhancement is the inclusion of a “healthcare specific user interface with descriptive symbols” such as a person in a wheelchair. Higher level abstractions of treatment paths are also possible using Diagnosis-Related Group (DRG) costings (IDS Scheer 2004).

However the ARIS Healthcare Solution is only available in German with no release date for an English version planned. There has also been limited use of the toolset in ‘realtime’ hospital settings, with details of only one project at Marienhospital Herne available from the vendor (IDS Scheer 2005).

As discussed in Chapter 2 all ARIS developments are based on the ARIS House which is made up of a number of views that aid in structuring and streamlining business process models and reducing redundancy. These views include Function, Organisation, Data, Output and Control. The primary tool used to develop patient journey models is the ARIS Business Process Model Notation which is based on the ARIS Meta Business Process Model.

5.3.3.1  ARIS Meta Business Process Model
Business Strategy analysis is initially conducted and then requirements for each ARIS House view are defined. Modeling within ARIS is based on the Meta Business Process Model and uses the ARIS Business Process Model Notation.

The Notation describes the classes associated with function enactment as shown in Figure 5.11. Functions are triggered by a start event and conclude with a result or end event. Contributing classes include organisational units, staff and other resource requirements such as machines and computer software and hardware. Flows between classes are depicted by directional arrows with each type of flow
represented by a different arrow type and/or head. Additional inputs and outputs may include Information or Other Services, Materials, Financial Resources and Environmental Data. Goals derived from the business strategy are also defined as part of the business process model.

Figure 5.11 ARIS Business Process Model Notation (Scheer 1998)

Figure 5.12 represents the case study using the ARIS business process modeling notation. Note: this model uses the ARIS Business Solution notation as the ARIS Healthcare Solution is not available in English.

Figure 5.12 ARIS Business Process Model – RMGP Suitability Assessment
The function *Assess Woman’s Suitability* can be further exploded to show the sub-processes involved using the same semantic process modeling structure, although no notation is available to indicate the existence of such sub-processes. Additional details such as what forms are completed as part of the clerical booking cannot be captured on the graphical model.

### 5.3.4 UML

Unified Modeling Language (UML) is an object-oriented approach to systems development. First released in 1997 by the Object Management Group, UML is one of the most widely used modeling languages available (Object Management Group 1997; Unhelkar 2005).

The key benefits of the UML approach relate to the fact that the language and its tools (diagrams) can be used throughout the systems development process from gathering systems requirements to implementation of the final system (Unhelkar 2005).

UML’s main contribution to the Healthcare domain is its use in the development of the HL7 Reference Information Model (RIM). The HL7 RIM is a “comprehensive framework for the exchange, integration, sharing and retrieval of electronic health information that supports clinical practice and the management, delivery and evaluation of health services” (Health Level 7 2005, p.3). HL7 is currently the predominate standard for the interfacing of clinical data in most institutions (Health Level 7 2005).

HL7 as a standard does not deal with the modeling of patient journeys but rather the data that needs to be passed between systems. Notwithstanding this, it is important to consider a HL7 compliant modeling method for review. This ensures that the transfer of the UML models to HL7 compatible environments can be facilitated.

The UML tool selected for review is the UML Business Process Modeling Notation (BPMN) as discussed in Chapter 2. The specification for the UML BPMN states that “BPMN will be constrained to support only the concepts of modeling that are
applicable to business processes” (Object Management Group 2006, p.34). The BPMN specification defines the notation and semantics of a Business Process Diagram (BPD).

5.3.4.1 Business Process Diagram
Business Process Diagrams (BPDs) are intended for use by the people who design and manage business processes. BPD’s can then be used by technical developers to formally map the process specifications to an execution language for the implementation of a Business Process Management System (Object Management Group 2006). A BPD is based on traditional flowcharting conventions but also includes formalisms for the creation of executable constructs.

A basic BPD is made up of four core categories of elements (Object Management Group 2006):

- **Flow Objects** – key graphical elements used to define the behaviour of business processes;
- **Connecting Objects** – connect the flow objects to each other and other information;
- **Swimlanes** – used to organise activities into separate visual groups to show different functional responsibilities;
- **Artifacts** – provide additional information about processes.

Key concepts within the BPD are Processes, Activities and Events. A Process is depicted as a graph of Flow Objects. Processes may be defined at any level from enterprise-wide processes to processes performed by a single person. Low-level processes may be grouped together to achieve a common business goal. Processes can be categorised as three basic types:

- **Private (internal) business processes** – only relate to and affect the internal running of the business
- **Abstract (public) processes** – includes those private processes that communicate with the outside world
- **Collaboration (global) processes** – depicts the interaction of two or more individual business entities.

(Object Management Group 2006)
An *activity* is work that is performed within a business process. An activity can be atomic or non-atomic (compound). An *Event* is a ‘trigger’ that occurs as a part of a Process and affects the flow of the process stream (Object Management Group 2006).

Organisational structures and Resources, Functional breakdowns, Data and information models, Strategy and Business Rules are not currently represented in BPMN (Object Management Group 2006).

The use of swimlanes in BPMN is optional although many BPMN examples do utilise them. Each participant (including systems) is allocated to a separate swimlane and the processes relating to a particular participant can only be shown within that participants specific horizontal lane. Interactions amongst participants are depicted by arrows. Arrows may cross lanes in a multi-directional manner. Decision points are shown as diamonds and entry and exit points as terminators. Notes associated with processes are also permitted but are not mandatory.

An example of the notation for a Business Process Diagram is shown in Figure 5.13

![Figure 5.13. An Example of the Notation for a Business Process Diagram (Object Management Group 2006)](image-url)
Definition of the business process diagrams using BPMN allows the resulting models to be mapped to a number of lower-level execution languages. *Business Process Execution Language for Web Services (BPEL4WS)* is the primary execution language used under the current specification with each private business process requiring a separate BPEL4WS mapping. BPEL4WS is an XML based language and as such is transportable across disparate systems.

The next three figures show the case study problem using the BPMN syntax.
Figure 5.15 BPMN – RMGP Suitability Assessment - page 2

Figure 5.16 BPMN – RMGP Suitability Assessment - page 3
The following section evaluates the selected modeling methods/techniques using the new *Process Modeling Assessment Framework for Healthcare*.

### 5.4 Process Model Method Evaluation using the Assessment Framework

The *Process Modeling Assessment Framework for Healthcare* (PMAF4HC or simply the *Assessment Framework*) has been designed to assess the applicability and level of support provided for healthcare improvement activities, specifically incorporating Patient Journey Modeling.

The design of the questions is based on the *Patient Journey Modeling Meta-Methodology (PJM)* presented in Chapter 4. Another key input is the business process modeling review conducted by McGregor (2002) as part of the development of the *Intelligent Workflow Monitoring System (IW-MONS)* and discussed in McGregor and Edwards (2005). Subsequently the *Assessment Framework* also formed a cornerstone for the development of an innovative multi-dimensional patient journey modeling tool (*PaJMa*) as described in Chapter 7.

The construct of the questions is based on the above as well as an extensive literature review, discussions with research colleagues and experiences of the author during the case study improvement project. As such the *Assessment Framework* has three main foci:

1) The intuitiveness of the process model development activity to healthcare workers involved in patient journey improvement projects

2) The alignment of process improvement initiatives to the Provider’s strategy and

3) Basic semantic issues associated with model completeness, validity and formalism.

Section 5.3 saw the development of process models for the primary-care maternity service case study using four different process modeling methods/techniques. These
models are now evaluated using the *Assessment Framework*. The results of the evaluations are shown in Table 5.1.

### 5.4.1 Assessment Results

<table>
<thead>
<tr>
<th>Id</th>
<th>Short Description</th>
<th>Lean</th>
<th>Six Sigma</th>
<th>ARIS</th>
<th>UML-BPMN</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPS1</td>
<td>Healthcare Strategy Defn</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>HPS2</td>
<td>Strategic Objectives Defn</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>HPS3</td>
<td>Include Objs on Model</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>PJM1</td>
<td>Domain Specific Model</td>
<td>No</td>
<td>No</td>
<td>Partial</td>
<td>No</td>
</tr>
<tr>
<td>PJM2</td>
<td>Meaningful HC lang/notation</td>
<td>Partial</td>
<td>Generic</td>
<td>Partial</td>
<td>Generic</td>
</tr>
<tr>
<td>PJM3</td>
<td>Degree of Intuitiveness</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>PJM4</td>
<td>Multi-dimensional Rels</td>
<td>Partial</td>
<td>Partial</td>
<td>Partial</td>
<td>Partial</td>
</tr>
<tr>
<td>PJM5</td>
<td>Hierarchical Process Defn</td>
<td>No</td>
<td>Partial</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>PJM6</td>
<td>Data flows</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>PJM7</td>
<td>Conditional Paths</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>PJM8</td>
<td>Process Fallout</td>
<td>Implicit</td>
<td>Implicit</td>
<td>Implicit</td>
<td>Implicit</td>
</tr>
<tr>
<td>PJM9</td>
<td>Flow of Control</td>
<td>Basic</td>
<td>Basic</td>
<td>Basic</td>
<td>Basic</td>
</tr>
<tr>
<td>PJM10</td>
<td>Process Completion Times</td>
<td>Yes</td>
<td>No</td>
<td>Implied</td>
<td>No</td>
</tr>
<tr>
<td>PJM11</td>
<td>Other Process Metrics</td>
<td>Separate</td>
<td>Separate</td>
<td>Implied</td>
<td>No</td>
</tr>
<tr>
<td>PJM12</td>
<td>Discontinuity of Care/Care Handover</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
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<tr>
<td>HR1</td>
<td>Internal/External Roles</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>HR2</td>
<td>Role Linked to Process</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>HR3</td>
<td>Role Skill Type/Level</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
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<tr>
<td>HR4</td>
<td>Org Structure Defn</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>HR5</td>
<td>Roles on Model</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>HR6</td>
<td>Differentiation of Roles</td>
<td>Partial</td>
<td>Yes</td>
<td>Partial</td>
<td>Yes</td>
</tr>
<tr>
<td>PR1</td>
<td>Physical Resource by Proc</td>
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<td>Partial</td>
<td>Yes</td>
<td>Partial</td>
</tr>
<tr>
<td>PR2</td>
<td>Physical Res Responsibility</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>PN1</td>
<td>Socio/economic Needs Defn</td>
<td>No</td>
<td>No</td>
<td>Generic</td>
<td>No</td>
</tr>
<tr>
<td>PN2</td>
<td>Cultural/religious Needs Defn</td>
<td>No</td>
<td>No</td>
<td>Generic</td>
<td>No</td>
</tr>
<tr>
<td>PN3</td>
<td>Needs on Model</td>
<td>No</td>
<td>No</td>
<td>Generic</td>
<td>No</td>
</tr>
<tr>
<td>A1</td>
<td>Policy/Guideline Defn</td>
<td>No</td>
<td>No</td>
<td>Generic</td>
<td>No</td>
</tr>
<tr>
<td>A2</td>
<td>Policy/Guideline on Model</td>
<td>No</td>
<td>No</td>
<td>Generic</td>
<td>No</td>
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<tr>
<td>PC1</td>
<td>Practice G/L linked to Process</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>SD1</td>
<td>Process Data Reqs Defn</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>SD2</td>
<td>IS to Process Rel</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>SD3</td>
<td>Information Flows on Model</td>
<td>Explicit</td>
<td>Implicit</td>
<td>Explicit</td>
<td>Implicit</td>
</tr>
<tr>
<td>M1</td>
<td>Link to Strategic Objs</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>M2</td>
<td>Measurements on Model</td>
<td>Operational</td>
<td>No</td>
<td>Goal</td>
<td>No</td>
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<tr>
<td>TS1</td>
<td>Software Support</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>TS2</td>
<td>Output Workflow Defns</td>
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<td>No</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>TS3</td>
<td>Output DSS Algorithms</td>
<td>No</td>
<td>No</td>
<td>Partial</td>
<td>No</td>
</tr>
</tbody>
</table>

*Table 5.1. Process Modeling Assessment Results*

The Table above summarises the findings of the process modeling evaluation exercise. Appendix A lists the questions for each category in full. The aim of the questions is to assess the level of support specifically provided for healthcare process improvement activities encompassing patient journey modeling.
Discussion regarding the structure of the *Assessment Framework* and the evaluation results follows.

### 5.4.2 Framework Description and Evaluation Summary

The *Framework* is presented in tabular format. Reading from left to right, the Framework starts with two main columns on the left, with additional columns added for each process modeling technique/method being assessed.

*Column 1* is headed ‘Id’ and lists the assessment category code and question number. For example the first entry in the ‘Id’ column is ‘HPS1’ which identifies question number 1 in the Healthcare Provider Strategy category. *Column 2* is headed ‘Short Description’ and as the name suggests provides a brief description of the actual question being assessed. Additional columns are then added as needed for each process model being evaluated. The different categories of questions are delineated via the inclusion or exclusion of grey shading.

The following sections firstly describe each question category and then discuss the results of the assessment in more detail with specific references to the level of support provided by the individual methods evaluated.

#### 5.4.2.1 Healthcare Provider Strategy (HPS)

This category of assessment deals with the ability of each process modeling technique to capture the healthcare provider’s strategy and objectives and flow this information through to the patient journey model. Process improvements that align with strategy will go unconfirmed if organisational metrics cannot be tracked at an operational workflow level.

Of the methods reviewed only *Six Sigma* and *ARIS* catered for the analysis of the business strategy. In *Six Sigma*, business objectives and needs are captured in the *Define* phase and are mainly focused on financial benefits and defects per million opportunities. Although these are not explicitly linked to the business strategy, the method implies that project objectives are derived from the business case which should be developed prior to the commencement of the Six Sigma project. *ARIS* addresses strategy as part of the *Strategic Business Process Analysis* phase which is
conducted prior to definition of the individual ARIS views. This flows through to the Business Process Model in the form of goals attached to each function.

The specification for the UML Business Process Modeling Notation explicitly states that items such as Strategy, Organisational structures and Resources, Functional breakdowns, Data and information models and Business Rules are not supported in the current version. It is acknowledged however that these types of high-level modeling concepts either directly or indirectly affects business processes. The relationships between BPMN and other high-level business modeling items will be defined more formally as BPMN and other specifications are advanced (Object Management Group 2006). Lean Thinking discusses the identification of a ‘problem’ product family but does not link this to business strategy as part of the method (Rother and Shook 2003).

5.4.2.2 Patient Journey Modeling (PJM)

The applicability and degree of support provided by particular techniques to the healthcare domain for the actual development of the patient journey model is the main focus of this group of questions. As a domain specific process modeling method is unavailable, it is vital to determine whether current techniques satisfy the requirements for patient journey modeling. The level of intuitiveness, healthcare concept expression and understandability by stakeholders are firstly assessed. More technical modeling concepts relating to the capture of metrics, control of process flow and process fallout are then addressed.

The comparison of items in this category falls into two main areas: 1) look, use and intuitiveness of the process models to healthcare staff involved in healthcare process improvement 2) basic semantic issues associated with model completeness, validity and formalism.

Only ARIS purports to offer a healthcare specific solution, although modeling within this toolset is still based on the native ARIS method with the addition of a number of healthcare specific libraries. Although Lean Thinking is the most widely used patient journey modeling method it is still a non-healthcare specific process
improvement technique notwithstanding that the current tool support does provide some healthcare specific modeling icons (see next comment).

**Lean Thinking** and **ARIS Healthcare Solution** provide limited icon libraries and associated modeling language that users would find useful when describing healthcare processes. Although **ARIS Healthcare Solution** provides a domain specific modeling grammar, the development of the ARIS business process model is the least intuitive as the patient cannot be differentiated from other process participants except by name. All of the methods provide links to a limited number of other dimensions associated with the patient journey, primarily staff and information systems. Lean is the only method that does not provide an explicit link to hierarchical process definitions. Six Sigma uses a **SIPOC diagram** to denote high level functions and **Process Maps** to define lower level processes. There is no ability to indicate sub-processes on the **Six Sigma, Lean Thinking** or **ARIS Models**. **BPMN** indicates sub-processes via the inclusion of a ’+’ in the parent process symbol.

**Six Sigma** and **BPMN** lack a notation for representing the flow of information and data and these can only be represented as a note on the model. All methods allow conditional paths to be depicted. Process fallout is explicit in all methods except **ARIS** where fallout is implied only via the woman’s association with a process. **Lean Thinking** is the only method that explicitly shows the process completion times on the model. **ARIS** supports the definition of goal metrics (including time) but specification of actual process measurements is supported only through the ARIS software toolset and is not shown on the graphical model. **Six Sigma** supports metric definition also but this is only through the inclusion of an additional and separate **Six Sigma** artifact. None of the methods explicitly show discontinuities of care and/or care handovers. Care handovers are only implied via the inclusion or exclusion of a healthcare worker role or the relationship between healthcare workers as depicted by directional arrows.

It should be noted that three different notation sets and modeling representations were found in the **Six Sigma** resources reviewed. This type of conflict adds an unnecessary and confusing overhead for those inexperienced in model development.
5.4.2.3 Human Resources (HR)
This series of questions looks at how well human resource requirements are catered for. Specifically the skill levels and types that different processes require are considered along with the ability to overlay an organisational structure that includes internal and external roles.

All methods permit internal and external roles to be shown on the process model and linked to a process, although none of the methods allow skill type/level to be linked to a role. Only ARIS provides a mechanism for defining the organisational structure. Roles are differentiated via the use of swimlanes in Six Sigma and BPMN. Lean Thinking provides a number of icons representing a limited number of different healthcare workers and ARIS distinguishes roles only by role name.

5.4.2.4 Physical Resources (PR)
Along similar lines to the human resource questions, this category assesses the models ability to define physical resource requirements for each process and what area is responsible for them.

None of the methods show who or what section/department/organisation is responsible for a physical resource used by a process. Physical resources are implicitly related via directional arrows in Lean Thinking and ARIS. Six Sigma and BPMN have no notation for depicting physical resource usage on the process model.

5.4.2.5 Patient Needs (PN)
The critical focus of a patient-centered approach to healthcare improvement is the ability of models to define the needs of the patient as they flow through the ‘system’. Areas such as socio-economic and cultural needs are considered along with the ability to highlight these on the model.

Only ARIS provides a mechanism for defining socio-economic or cultural patient needs on the process model although this is only through the inclusion of an ‘environmental data’ or ‘input/output’ symbol attached to a process. This notation is however generic to any type of ‘environmental data’ or ‘input/output’ associated with process enactment and is not specific to patient needs.
5.4.2.6 Administration (A)
Safe and reliable healthcare cannot be delivered without consideration to hospital policies and guidelines relating to the administration of patients (Practice Guidelines are dealt with separately; See 5.4.2.7). Such documentation will affect how patients make their journey and what paperwork is required to be completed. This category of questions deals with the relationship of required policies and administration guidelines to the flow of processes and their representation on the process model.

In a similar manner to Patient Needs, ARIS permits Administration and Policy Guidelines to be attached to a process via generic ‘environmental data’ or ‘input/output’ notation only. Inclusion of a note in Six Sigma and BPMN may denote that Administration and/or Policy Guidelines are associated with a process although this is not mandatory in either of these methods.

5.4.2.7 Practice Guidelines (PG)
Delivery of high quality healthcare primarily affects patient outcomes which in turn contribute to patient satisfaction levels and ultimately the reputation of the HCO. By linking processes to clinical best-practice guidelines, process improvements will be inherently linked with higher care standards and definitive measurement data on improved patient outcomes.

The ARIS Healthcare Solution provides the only specific tool adaptation that permits treatment path mapping and higher level concepts such as DRG costings. Any reference to practice guidelines within the other methods is via the inclusion of a process ‘note’ and this is not a mandatory method notation for these items.

5.4.2.8 Systems Data (SD)
This group of questions assesses how data required for process enactment is depicted. This may be at the information system level or for an individual data group. This is important in eliminating duplication of data capture and storage and improving communication of patient data as patients move between healthcare workers.

None of the methods accommodate the capture of process data attributes. Information systems can be related to a process in all methods but only at the macro
application system level and not at the micro data level. Within BPMN and Six Sigma information flows are implied only through the inclusion of a process ‘note’. Specific information icons exist within Lean Thinking and ARIS.

5.4.2.9 Measurements (M)
Any improvements to process flow must be measured against previous situations to assess if the change has been successful. This will include being able to capture a wide variety of measurements including process timings, costs and satisfaction levels and linking these to the Provider’s strategy. These are the areas considered by this category of questions.

Only ARIS provides for the explicit linking of strategic objective goals on the process model. Lean Thinking provides for the capture of completion time measurements on the model but these are at the operational level only and there are no explicit links to the strategic objectives. Other measurements can be defined in Lean but these are a separate artefact and are not explicitly linked back to the process model. Six Sigma also provides for the definition of metrics associated with a process but again these are captured in a separate Six Sigma artefact and do not have any explicit links back to the process model. Any links to strategic objectives within Six Sigma are implied only.

5.4.2.10 Technology Support (TS)
This series of questions assesses the level of technical support provided for the process modeling method. It considers the degree of support at a range of levels including design, implementation and post-implementation performance monitoring.

All of the reviewed methods are supported by software technology. BPMN and Six Sigma software notation are the simplest to use and most intuitive, followed by Lean Thinking and ARIS respectively.

ARIS and BPMN provide for the output of process workflow definitions in an XML-based execution language. ARIS also considers decision support system outputs through the inclusion of the ARIS Controlling Platform, a separate, but related module, to that used for business process modeling.
5.5 Conclusion

To date the Healthcare domain lacks a design and modeling methodology adequately tailored to support the specific requirements involved with redesigning patient journey practices from a patient-centric perspective. Projects thus far have adopted methodologies from other non-healthcare disciplines.

This chapter provided a solution to research hypothesis 3 through the demonstration of a Process Modeling Assessment Framework for Healthcare (PMAF4HC). This tool can be used by healthcare improvement teams to evaluate the level of support being afforded to them by the process modeling method/technique selected for development of the nominated patient journey models.

Identification of low levels or complete lack of support in particular areas alerts the team to areas of weakness and the fact that other tools/techniques may be required to augment the patient journey modeling activity to improve the chances of high quality results.

The Assessment Framework can also be used as a benchmark for the development of new patient journey modeling tools as presented in Chapter 7.

Four process modeling methods/techniques used within the healthcare domain for process improvement were described along with the graphical notations used to develop each of the particular process models. The methods/techniques were chosen due to their frequency of use and/or their relationship to other significant healthcare domain initiatives such as HL7. Each method/technique was applied to the case study involving midwife-led primary-care maternity services in an Australian hospital. Each of the methods was evaluated in regards to their level of support for patient journey modeling using the Assessment Framework. The Assessment summary outlined the strengths and weaknesses of each resulting model. Highlighted weaknesses need to be addressed for the purposes of increasing the level of support currently provided to the healthcare environment for patient journey modeling.
Of the methods evaluated only ARIS partially covered some of the more critical areas such as the capture of organisational goals and the socio/economic and cultural needs of patients, although this is in the form of a generic ‘environmental data’ object only. Although the ARIS method covered more of the given assessment areas than other methods it was the least intuitive to use and this is seen as a major disadvantage for healthcare workers involved in process improvement initiatives. None of the methods are patient centric or identify discontinuities of care or patient handovers. The ability to define the role type and skill level required to deliver a particular clinical treatment and who is responsible for a given physical resource is also lacking.

Due to the huge interest in improving healthcare delivery and therefore the fundamental processes enacted in the provision of safe, high quality care, the accurate and comprehensive modelling of the patient’s journey is of critical importance. This suggests that more focussed attention needs to be given to the enhancement of existing process modelling methods/techniques and/or the development of healthcare domain specific patient journey modelling tools.
CHAPTER 6
PJM² – A MULTI-DIMENSIONAL PATIENT JOURNEY MODELING CONCEPTUAL DESIGN

6.1 Introduction

This chapter describes an original conceptual design of the multiple dimensions required to support the development of comprehensive high quality patient journey models. The conceptual design is abstracted from the Patient Journey Modeling Meta-Methodology (PJM³) presented in chapter 4 and is known as the Multi-Dimensional Patient Journey Modeling Conceptual Design or PJM².

PJM² sets the foundation for the development of solutions to research hypotheses 3 and 4 as discussed in Chapter 1. Specifically it provides a basic design of the components required in the development of two key patient journey improvement instruments:

1) **Healthcare specific patient journey modeling tools**
   When combined with the Assessment Framework discussed in Chapter 5, the conceptual design forms a robust blueprint for the construction of patient journey modeling tools purpose built for the healthcare domain. This can assist healthcare redesign teams to breakdown the complexities associated with modeling patient journeys into manageable ‘segments’ or dimensions.

2) **Database designs to support healthcare specific patient journey models**
   Purpose built healthcare domain patient journey models necessitate the consideration of complimentary supporting technology. This includes databases that will enable management to assess performance of the new
patient journey to pre-defined measurement targets as discussed in the Meta-Methodology (PJM³).

This chapter presents an outline of PJM² including a description of each of the contributing dimensions and their impact on the patient journey redesign activity.

The following two chapters will see the Conceptual Design bought together with the work presented in Chapters 4 and 5. This culminates in the development of a new healthcare specific patient journey modeling tool (chapter 7) and accompanying database design (chapter 8) as discussed in points 1 and 2 above.

### 6.2 Multi-dimensional patient journey modeling - A conceptual design (PJM²)

Patient journey models are part of a complex and highly inter-related set of workflows and procedures, involving many stakeholders. When developing the patient journey model multiple dimensions associated with the patient’s movement through the Health Care Organisation (HCO) must be analysed and it is only through the consideration of the inter-relationships and interactivity of all of these dimensions, that a complete and accurate picture of the patient journey can be realized (Curry et al. 2006; Jensen et al. 2006).

Camann (2001) also recognised that there was a missing link in the process redesign of care outcomes when suggesting that a conceptual model of patient and healthcare system variables was needed to verify outcomes research. She suggested that conceptual modeling can be applied to outcomes research to provide a framework for illustrating specific variables to be studied or results to be applied.

*The Multidimensional Patient Journey Modeling Conceptual Design (PJM²)* shown in Figure 6.1 presents a conceptual overview of the multiple contributing dimensions and their inter-relationships, that must be considered as part of the patient journey modeling exercise. PJM² is abstracted directly from the Patient Journey Modeling Meta-Methodology (PJM³) discussed in Chapter 4 and provides a portal through which to view the complex environment of healthcare improvement, in particular patient journey models.
Figure 6.1. A Multidimensional Patient Journey Modeling Conceptual Design (PJM²)
PJM\(^2\) – A Multi-Dimensional Patient Journey Modeling Conceptual Design

\(PJM^2\) takes the multiple facets involved in patient journeys and segments them into logical subject areas. Such a conceptualisation can be used in a variety of areas either as a standalone tool or in combination with other tools such as the *Assessment Framework*. Potential uses include evaluating existing patient journey modeling tools, constructing new domain specific patient journey modeling tools, developing models of the current and future patient journey and/or selecting supporting technology. For example, when developing the future patient journey model, each subject area can be considered as a single entity or combined with another, depending on the audience involved and the processes being analysed. This prevents those developing the models becoming overwhelmed with information thus allowing them to focus on specific parts of the problem domain. In this way the overall patient journey model is built up gradually over time therefore facilitating progressive understanding of the entire journey continuum.

Apart from the actual journey of the patient, nine (9) dimensions have been recognised as contributing to an accurate picture of the movement of a patient through the HCO.

- Strategic Objectives Dimension
- Human Resources Dimension
- Physical Resources Dimension
- Patient Needs Dimension
- Practice Guidelines Dimension
- Administration Dimension
- Technology Support Dimension
- Measurements Dimension
- Organisational Structure Dimension
Each of these dimensions may model an aspect of the HCO in its own right but only contributes to improving a situation when applied in the context of a particular patient journey. It must be highlighted that although the patient journey model is the ‘hub’ of this type of process redesign activity, each and every dimension can interact with and impact other dimensions. This suggests that each and every dimension must be fully analysed and understood in relation to its impact on the safe and efficient journey of a patient to ensure a comprehensive and accurate future patient journey model is developed.

It is suggested that the exclusion of one or more of the PJM$^2$ dimensions will reduce the effectiveness of the patient journey modeling exercise and negatively impact overall patient safety and improved outcomes goals.

Multidimensional approaches have been recognised as being of significance to other types of organisations such as manufacturing, insurance, banking and travel (Inmon 1996; Kimball 1996) and can be implemented using multi-dimensional database structures. Such database designs are seen most commonly in data warehouse architectures that support executive and management information systems and decision support systems. As discussed in Chapter 4, Decision Support Systems form a core component of the PJM$^3$ improvement architecture.

The following sections describe the PJM$^2$ framework starting with the core component; the patient journey model. Each of the contributing dimensions are then outlined and their interrelationship to other components discussed.
6.2.1 The Patient Journey Model

Development of the patient journey models (current and future) requires input from a broad range of stakeholders, each of whom contribute to the patient’s experience as they move through the HCO. Seila (2005) suggests that developing health care models requires health system managers and care givers to collaborate with modelers. However he points out that this can be difficult due to the different cultures and values held by both groups.

Notwithstanding such issues, patient journey models cannot be developed in isolation by only one section of the organisation. All of the stakeholders must contribute to the development of the model if it is to accurately represent the patient’s journey. In addition to the professional stakeholders involved, it is a standard requirement that patient’s who have recently experienced the journey under review be included in the analysis and redesign process.

A recognised method for eliciting requirements from diverse groups is a technique known as Joint Application Development (JAD). JAD was a process originally developed for designing computer-based business systems in the early 1980’s. However JAD has evolved to be used in a wider variety of situations, not just systems development, and is now described as a joint venture among people who need to make decisions affecting multiple areas of an organisation (Wood and Silver 1995). JAD sessions are run by an experienced facilitator whose role it is to guide the process and structure of the sessions whilst encouraging the participants to share their knowledge and expertise to arrive at a problem solution design. The aims of such facilitated workgroups are to achieve a shared understanding of the issues facing the group, a sense of common purpose and a mutual commitment to action (Phillips and Phillips 1993).

As part of the JAD sessions, patient journey stakeholders are bought together and through the use a trained facilitator, their diverse contributions outlining the journey of patients and the processes involved in their care are extracted and represented as a graphical patient journey model (PJM). As discussed above this is far too complex an exercise to attack as a single mass and must be broken down into manageable segments. In PJM², each segment is known as a dimension. By using individual
dimensions, JAD participants are able to understand and categorise the different items that contribute to the overall development of the PJM. Initially they can work with one or two dimensions and then bring the dimensions together as their group understanding increases. This allows for more comprehensive analysis and design of current journey deficiencies and potential improvements.

A new diagrammatic approach to patient journey modeling is presented in Chapter 7 and it is in this chapter that comprehensive details regarding the graphical representation of each of the $PJM^2$ dimensions are presented.

### 6.2.2 Strategic Objectives Dimension

The Strategic Objectives Dimension defines the specific mission, strategic directions and related objectives that guide the organisation and how it delivers its services to its specified clients. Aspects of the Strategic Objectives Dimension may be applicable across different patient journey models or only to a nominated patient journey (viz: diabetes, cardiac, renal) and must include consideration of applicable legislation, accreditation requirements, government/hospital policies and patient population needs. In saying that each Strategic Objectives Dimension is specific to the Patient Journey Model under review it must be acknowledged that although objectives can be set at multiple levels of the organisation, viz, strategic, management and operational (Lemieux-Charles et al. 2003), certain HCO mission-based objectives will be present in all models (ie: patient satisfaction). All Strategic Objective measurements are linked to the Measurements Dimension for the purposes of analysis of target to actual figures, once the redesigned patient journey is enacted.

Key sources of strategic objectives are Government and accreditation bodies that set policy for the industry as a whole. Examples include the national agenda of the Australian Council on Safety and Quality in Healthcare as supported by the Australian Council on Healthcare Standards (ACHS) Evaluation and Quality Improvement Program (EQuIP) (ACHS 1996; ACSQH 2006) and the National Patient Safety Goals as defined by The Joint Commission (JCAHO 2006).

Definition of the contents of this dimension involves describing the HCO strategic objectives in the form of the OHA adapted Balanced Scorecards as outlined in
Chapters 2 and 4 (Ontario Hospital Association 1999). Initially the mission and vision of the HCO are reviewed along with existing strategic objectives. Definition of the strategic objectives is then categorised into one of the four BSC perspectives.

Starting with the definition of the actual objectives for a given perspective, the variables that will be used to measure to what degree the objectives are being achieved are listed. Target or planned variable values are then set for each measurement. Initiatives that can lead to the realisation of the set targets are also included.

6.2.3 Human Resources Dimension
The Human Resources Dimension describes the staffing structure required to adequately support the flow of the patient through the patient journey under review. It defines actual positions and numbers required, skills/roles and section or department responsible for a specified resource within the patient journey model. Costs of supplying the required human resources are also captured as part of the Human Resources Dimension along with figures regarding target human resource numbers required by a process.

6.2.4 Physical Resources Dimension
The Physical Resources Dimension describes what and how many of each associated physical resource such as, space and equipment, (excluding human resources), are required to support the activities described for each process in the Patient Journey Model. Financials for each physical resource must also be calculated. This includes purchase costs and on-going maintenance fees for equipment. When describing a process as part of the patient journey not only must the space requirements (ie: room size and type) be specified but also the physical equipment needed to complete the process (ie: ultrasound machine, blood pressure machine).

6.2.5 Patient Needs Dimension
The Patient Needs Dimension defines the unique socio and cultural requirements of specific patient groups that flow through a nominated patient journey. This Dimension is of particular concern in low socio-economic or indigenous areas.
Other categories of patient needs can also be classified in this Dimension based on specific co-morbidity groups or carer requirements. Measurements relating to the provision of a ‘culturally safe’ care plan are linked to the Measurement Dimensions for variance analysis following the enactment of the patient journey workflows to determine the degree of compliance and/or the need for greater vigilance.

For example, one traditional Australian Aboriginal custom involves a ‘smoking ceremony’ for the placenta of new born babies. In days gone by, the placenta was placed in a grass mound, the grass was lit and the resulting smoke served to cleanse the placenta of bad spirits and bring good luck to the new life. The option of storing and transporting the placenta of newborn babies is no longer offered to indigenous women who birth at public hospitals in Australia and can cause disharmony within the woman and her tribe once she has returned to her ‘local’ land.

### 6.2.6 Practice Guidelines

Output from the HCO Strategy analysis will include practice guidelines that are required to comply with or attain accreditation. This will include items such as evidence-based best practice and clinical indicators. The goal is to remove variability in the process of care where possible thus increasing the quality of the care delivered and the overall outcomes. Practice guidelines may apply to different types of staff (nurses, doctors etc.) or for any type of healthcare worker delivering a specific type of care (ventilator support). These may form part of an overall quality improvement program such as the Evaluation and Quality Improvement Program (EQuIP) administered by The Australian Council on Healthcare Standards (ACHS 1996) or be published by a particular professional body such as the National Midwifery Guidelines for Consultation and Referral by the Australian College of Midwives (Australian College of Midwives 2004).

At the operational level, benchmark clinical indicators may also be required to support measurement of the use and effectiveness of certain practice guidelines. A clinical indicator is defined as a measure of the clinical management and/or outcome of care. Indicators are best seen as measures that screen for a particular event. These are typically developed in conjunction with medical colleges, associations and societies. Examples include the Sentinel Event Alerts from the Joint Commission for
Accreditation of Healthcare Organisations (JCAHO 2005) and the *Performance and Outcomes Service Clinical Indicators* from The Australian Council on Healthcare Standards (ACHS 1996).

Clinical indicators will be linked to the *Measurements Dimension* using Clinical indicator identifiers and targets. These will be used for future variance analysis post workflow enactment.

### 6.2.7 Administration Dimension

The *Administration Dimension* describes the type, source and movement of any paperwork (including forms) associated with the management of a patient and their journey and the manual or system administration tasks required to support the completion of these activities. Such data can be used to analyse problems relating to the smooth flow of patients within the system and to other external care providers and to provide pointers to potential problems in the clinical, financial and management areas (Diers and Bozzo 1999).

Also includes definition of responsibilities and approvals required via links to the *Human Resources Dimensions*. Specifications for system requirements for support for data capture, storage, retrieval and reporting as part of the *Administration Dimension* are linked to the *Technology Support Dimension*.

### 6.2.8 Technology Support Dimension

Technology may play a role in each of the Dimensions described above but we are particularly interested in the support provided for the patient journey under review. The *Technology Support Dimension* defines the systems required to support all of the activities associated with the flow of the patient through the nominated healthcare system and the analysis of the ongoing effectiveness of the journey itself. A key item of consideration here is the opportunity to automate workflows and provide clinical decision support at the point of care.
Technology support may be in the form of Hospital-wide systems or specialised systems catering for unique departmental needs. Examples of technology support for a patient journey may include electronic transfer of lab test or x-ray requests, integration of systems related to the overall patient journey or automation of existing manual processes. This is supported by Grotevant (1998) who suggested that Information Technology provides the infrastructure and tools, which fundamentally change organisations, but management provides the strategic vision that transforms technology into competitive advantage.

Analysis of the patient journey may lead to a realisation that technology support is lacking and this may initiate requests for new systems or enhancements to existing systems. The required data may actually already exist in another system and this may necessitate integration of a number of systems to provide a more comprehensive database that reduces the need for duplicate data entry and reporting.

Such findings may also require the purchase of new computing equipment (ie: data servers or handheld computers) and any new budget needs must be fed back into the Physical Resources Dimension as discussed above.

6.2.9 Measurements Dimension

NB: The terms measurement and metric are used synonymously in this thesis to represent the value assigned to a given variable that has been selected as an improvement indicator.

Measurement of healthcare improvement is the area of most interest to healthcare managers. Measurements provide the tangible values that assist in determining if there has been an improvement in productivity and/or quality. Measures of the current ‘as-is’ patient journey may provide the current benchmark or other recognised high performing service providers performance results may also be utilised, if available.

In general three types of measurement values are needed (as a minimum): ‘original’ (or pre-intervention), ‘target’ and ‘actual’. ‘Original’ values represent the journey as it was before the improvement exercise was undertaken. ‘Target’ values are those
that the HCO wants to achieve as part of the future patient journey implementation. ‘Actual’ values represent the results that are physically attained as a particular patient moves through the redesigned patient journey. Comparison of ‘original’ to ‘actual’ process measures represent the degree of improvement that can be attributed to the implemented changes. Comparison of ‘target’ to ‘actual’ results allow required performance levels to be highlighted for the purposes of variance analysis and ongoing process improvement.

The primary focus on measurement definition is usually clinical type indicators but it should be recognised that these are just one type of measurement. Metrics can be classified according to the aspects of care they address and can measure either (ACHS 2007):

- Structure (what is needed)
- Process (what is done)
- Outcome (what is achieved or expected).

The \( \text{PJM}^2 \) conceptual design caters for these measurement types through the use of multiple dimensions such as the Technology Support, Patient Journey and Strategic Objectives dimensions.

Metrics are used to assess, compare and determine the potential to improve care. Measurements should therefore be used as a tool to assist in assessing whether or not a standard is being met. The metrics provide evidence of performance and can be linked to Quality Improvement programs where applicable.

The previous discussion relates to the setting of healthcare improvement measurements in general but metrics for clinical indicators are typically high on the HCO agenda as they are most commonly used to gauge compliance to standards and prove accreditation criteria attainment.

Measuring improvement is acknowledged as an intricate activity and some of this complexity stems from approaches that attempt to define measurements for all areas at the same time. Such an approach leads to confusion as the number and
complexity of the areas to be considered is too great. The development of the multiple dimensions discussed above, helps to overcome such complexities by defining measurements for each specific part of the patient journey individually and then linking all of the measurements within the *Measurements dimension*.

### 6.2.10 Organisational Structure Dimension

The *Organisational Structure Dimension* defines the hierarchical reporting structure and lines of responsibility that exist within a given HCO. The *Organisational Structure Dimension* helps to identify which departments are responsible for particular aspects of the patient journey. This includes responsibility for human and physical resources, information systems etc....In *PJM*², the organisational structure is shown as a supporting dimension for all of the others. This is because all other dimensions have the organisational structure as a common aspect of their makeup.

Ideally the information for this dimension would already be in place in some other form (ie: paper based, accounting system etc…). If the organisational structure already exists and a paper report can be produced it can be used as is for the purposes of the patient journey modeling exercise. If the organisational structure data is not easily accessible it will need to be documented as an integral part of the overall PJM activity.

### 6.3 Conclusion

This chapter presented an original conceptual design describing the multiple dimensions contributing to the development of comprehensive patient journey improvements. The *Multi-Dimensional Patient Journey Modeling Conceptual Design (PJM*²) is abstracted directly from the *Patient Journey Modeling Meta-Methodology (PJM*³) presented in chapter 4.

*PJM*² provides a working blueprint of the multiple dimensions associated with a patient’s movement through the Healthcare Organisation and the inter-relationship and interactivity of these contributing dimensions. Nine contributing dimensions were discussed: Strategic Objectives, Human Resources, Physical Resources, Patient Needs, Practice Guidelines, Administration, Technology Support, Measurements and
Organisational Structure. The approach supports research hypotheses 3 and 4 as described in Chapter 1.

Effective patient journey modeling projects must consider all of the $PJM^2$ dimensions or risk negatively impacting patient safety and improvement outcomes.

Chapters 4, 5 and 6 have presented and discussed the environment required to redesign patient journeys for the purposes of improving patient safety, reducing care variability and keeping the patient at the centre of the care process. Chapters 7 and 8 consolidate this work and use it as the foundation for the development of two purpose built healthcare improvement instruments. Chapter 7 presents an innovative patient journey modeling tool that is cognisant of the requirements of $PJM^3$, the Assessment Framework and $PJM^2$ and incorporates these pre-requisites into the overall design of the new tool. Chapter 8 uses the same approach to underpin the development of an original multi-dimensional database design for a Management Decision Support System. This system is used by management to evaluate the changes made as a result of the redesigned patient journey and to determine if such changes are meeting the pre-defined project targets or if further changes are required as part of ongoing quality improvement efforts.
CHAPTER 7
PAJMA - A HEALTHCARE SPECIFIC PATIENT JOURNEY MODELING TOOL

7.1 Introduction

This chapter presents an innovative patient journey modeling tool that has been purpose built for the healthcare domain. The new graphically-based patient journey modeling tool is known as PaJMa (pronounced ‘pajama’) and supports the design of safe, high quality patient journeys.

PaJMa is the first patient journey modeling tool built specifically for healthcare from the ground up. The design is based on the Patient Journey Modeling Meta-Methodology (PJM™) and the Process Modeling Assessment Framework for Healthcare (PMAF4HC), discussed in Chapters 4 and 5 respectively. The multi-dimensional approach used in the model was derived directly from the Patient Journey Modeling Conceptual Design (PJM²) presented in Chapter 6 and allows redesign teams to breakdown the complexities associated with modeling patient journeys into manageable segments.

The development of the PaJMa tool provides a solution to research hypotheses 2 and 3 from Chapter 1. A key contribution lies in the fact that the tool can be used as a primary driver of healthcare improvement initiatives particularly in areas such as the promotion of stakeholder involvement, commitment and ownership, as well as highlighting the relationship of a range of relevant variables that impact the overall patient journey.
As discussed throughout this research work, quality improvement is high on the agenda of Health Care Organisations (HCO) worldwide. Patient Journey Modeling is a relatively recent innovation in healthcare quality improvement that models the patient’s movement through the HCO by viewing it from a patient centric perspective. Critical to the success of the redesigning care process is the involvement of all stakeholders and their commitment to actively participate in the process. Tools which promote this type of communication are a critical enabler that can significantly affect the overall process redesign outcomes. Such a tool must also be able to incorporate additional factors such as relevant policies and procedures, staff roles, patient needs, system usage and measurements such as process time and cost.

This chapter begins with a recap of the major deficiencies with the selected process modeling methods/techniques, in relation to the healthcare domain as highlighted by the Process Modeling Assessment conducted in Chapter 5. Following this is a discussion concerning the contributing domains impacting the development of the PaJMa tool. The overall architecture including the notation used to develop the PaJMa patient journey models is then presented.

The application of PaJMa is demonstrated via the midwife-led primary care case study previously described in Chapter 5. The case study will use the new PaJMa tool to develop a Current Patient Journey Model. The issues associated with the current patient flow will be discussed and improvements suggested. The same tool will then be used to develop an improved or Future Patient Journey Model, designed to overcome the highlighted issues and improve not only how the patient moves through the system but the overall quality and safety of the primary-care midwifery services offered.

7.2 PaJMa Tool Background

Chapter 5 evaluated the dominant process modeling methods/tools that are being used to redesign healthcare in the current climate of change. Each process modeling technique was assessed against a set of key criteria (PMAF4HC) considered
PaJMa – A Healthcare Specific Patient Journey Modeling Tool

necessary to adequately support high quality healthcare improvement initiatives. Some of the specific areas which were identified as being deficient include:

- Definition of Roles and skill types
- Definition and linking of resources to the organisational structure
- Highlighting of care handovers
- Definition of patient needs
- Definition of practice guidelines and policies and the linking of these to processes
- Definition of explicit multiple measurements (other than time)
- Definition of strategic objectives and linking of these to operational process measurements.

In addition, none of the modeling techniques evaluated are healthcare domain specific and therefore lack the ability to define the multiple dimensions associated with healthcare change thus making them highly unintuitive to healthcare workers involved in the redesigning care activity.

This indicates that any new patient journey modeling tool must aim to overcome these deficiencies if process modeling in the healthcare arena is to be improved. In addition the modelling technique must:

- Be consistent and simple to use
- Be understandable by a diverse range of stakeholders
- Enable ready recognition of patient journey issues
- Provide for automated process guidance and execution support.

(Curtis et al. 1992; Seila 2005)

Such aims necessitate the use of a cross-discipline approach such as that employed by the PaJMa tool. The PaJMa design brings together constructs from several complimentary disciplines. These include Process reengineering, Flowchart and Workflow modeling and Joint Application Development (JAD). By combining these approaches the stated aims can be achieved in a straightforward manner providing realistic and implementable solutions.
The PaJMa tool presented in this chapter provides such a foundation and can be used as a graphically based communication tool to develop patient journey models, analyse highlighted problems and redesign the overall journey, leading to reduced variations in the care pathway thus increasing the quality of care and improving patient outcomes.

### 7.2.1 Contributing Domains

**Process reengineering**

Process reengineering techniques have been used extensively in the business, manufacturing and computing domains (Hammer 1990; Womack *et al.* 1990; Davenport 1994) for many years but it is only in the recent past that process improvements in healthcare have been achieved through the use of similar reengineering approaches. Process reengineering activities invariably involve modeling of the business process flows.

Process reengineering supports (Davenport *et al.* 2003):

- Revolutionary process redesign and work improvements
- Across broad, cross-functional work processes
- Introducing stretch goals of order-of-magnitude improvement
- Using IT as an enabler of new ways of working

This suggests that healthcare improvement initiatives that utilise process reengineering are looking to substantially change the ways things are currently done, with an end goal of significant improvements in quality of care and outcomes.

Process reengineering through patient journey modeling has at its centre the needs and wants of the patient in relation to their progress through a healthcare system for a given service (NHS Modernisation Agency 2005; NHS Modernisation Agency 2005). This is typically in the context of a hospital but applies equally to general practice medicine and specialist services. Each time a patient interacts with a healthcare worker (including administration staff, management and clinicians) or is moved around the hospital the interaction is tracked and described.
The goal is to collect required information only once, reduce the number of times a patient is moved, eliminate excessive activities, remove duplicate communications, promote compliance to recognised practice guidelines and provide clear and concise information to the patient. This may mean substantial changes to the way people work at the present time, although due care should be given to ensuring that processes that are already performing well are not changed purely for the sake of it.

**Flowchart and Workflow modeling**

*PaJMa* has at its centre the visual representation of the processes involved with the patient’s journey overlaid with the different dimensions contributing to that journey including staff roles, information creation/movement, patient needs, practice guidelines/policies and metrics. The approach allows dimensions to be swapped in and out of the conversation depending on the context being discussed at the time. The *architecture* uses a number of flowcharting symbols as the platform for the graphical definition of the multiple layers (dimensions) involved in the complex arena of healthcare redesign.

**Joint Application Development**

Joint Application Development (JAD) is a recognised method for eliciting requirements from diverse groups and was a process originally developed in the early 1980’s for designing computer-based business systems. However JAD has evolved to be used in a wider variety of situations, not just systems development, and is now described as a joint venture among people who need to make decisions affecting multiple areas of an organisation (Wood and Silver 1995). The *PaJMa* development activity uses the techniques of Joint Application Development to bring stakeholders together for the purposes of patient journey modeling requirements gathering.

The key enabler to the success of this technique is the use of a facilitator whose role it is to guide the process and structure of the sessions whilst encouraging the participants to share their knowledge and expertise to arrive at a problem solution design. The aims of such facilitated workgroups are to achieve a shared understanding of the issues facing the group, a sense of common purpose and a mutual commitment to action (Phillips and Phillips 1993). The aims of JAD are very
relevant to healthcare quality improvement initiatives, however JAD as a practice does not provide any specific diagrammatic techniques to aid in the overall redesign of the patient’s journey.

As part of the JAD sessions, patient journey stakeholders, including patients, are bought together and through the use a trained facilitator, their diverse contributions outlining patient movements and interaction with service providers and the processes involved in their care, are extracted. The contributions of all stakeholder groups are bought together by the facilitator and represented as a graphical patient journey model (PJM).

### 7.2.2 Project Activities

Patient Journey Modeling projects are typically undertaken via a number of sequential stages as follows:

1. Firstly the scope of the patient journey model is discussed, agreed and documented;

2. Balanced Scorecard perspectives relevant to the journey being analysed are then reviewed. Goals for the improvement initiative must be clearly stated and agreed. Goals must also be able to be linked back to the Healthcare Provider's strategy to ensure they are adding value to the organisation’s overall direction;

3. Next the patient journey as it currently exists is modeled. This should be focused clearly on the patient and the effect processes have on their experience and outcomes, with each of the \( PJM^2 \) dimensions being explicitly considered. NB: A separate patient journey model is required for each co-morbidity;

4. Analysis of journey problem areas is then conducted and possible improvements highlighted. Each improvement must be considered for the effect it has on the project goals in relation to the patient, health care staff and the Healthcare Organisation. Evaluation of alternatives can be done using manual tools such as the 'Flow Master Matrix' by Jensen et al. (2006) or more advanced automated Simulation Modeling tools (Brailsford 2005). Ideally the alternatives that will have the greatest impact on the patient’s journey are selected for inclusion in the future PJM;
5. Once specific improvements have been decided an improved patient journey is developed. The Future Patient Journey Model shows how the journey will exist after all improvements have been implemented. Definition of journey metrics to assist in the comparison of the ‘old’ journey to the ‘new’ and ongoing evaluation of implemented improvements is also conducted.

6. On completion of the Future Patient Journey Model, an implementation plan is developed. The implementation plan is a timeline indicating when specific improvements will be introduced, by whom and in what areas. It should be noted that the future PJM may be implemented gradually over time depending on the work required to initiate a specific improvement. Each implementation iteration introduces one or a number of improvements until the ‘ideal’ journey is achieved. This is similar to the Model For Improvement’s PDSA cycles (IHI 2003). Possible time frames are immediate, short (within 4 weeks), medium (within 3 months) and long (within 6 months).

All of the information supporting the above activities is documented in an accompanying Project report. This report textually describes each stage, including process-by-process descriptions of the patient journey as well as the impacts and issues uncovered, alternative solutions discussed and selected and the future patient journey model implementation plan. The Patient Journey Modeling Project report provides evidence and background for the improvement recommendations made by the redesign team. These details are required by management to justify authorisation of any system enhancements, including allocation of new or existing resources.

7.3 **The PaJMa Architecture**

As discussed patient journey modeling (PJM) is far too complex an exercise to attack as a single mass and must therefore be broken down into controllable segments. In \( PJM^2 \), each segment is known as a dimension. By using individual dimensions, JAD participants are able to understand and categorise the different items that contribute to the overall development of the PJM. Initially they can work with one or two dimensions and then bring the dimensions together as their group understanding
increases. This allows for more comprehensive analysis and design of current journey deficiencies and recognition of potential improvements.

The patient journey modeling tool discussed in this chapter is multidimensional in nature and is developed in a facilitated JAD environment involving all of the stakeholders affected by the patient journey under review. Participants should include management, IT support staff, healthcare workers (including clinicians and specialists) and patients. The sessions are run by an experienced facilitator whose role it is to use the tool as a communication medium to encourage discussion and involvement amongst the participants and translate what is said into a resulting diagrammatic.

The PaJMa tool has at its centre the visual representation of the processes involved with the patient’s journey overlaid with the different dimensions contributing to that journey. The approach allows dimensions to be swapped in and out of the conversation depending on the context being discussed at the time. A dimension is synonymous with a layer when building and viewing the models. For example if the group is discussing staff roles as they relate to work processes then only these 2 dimensions (layers) of the tool need to be displayed. If the group then wishes to bring in details about the information that is created or updated as part of these processes then this dimension (layer) can be added. Such an approach allows the model to be built up gradually over time as more and more of the information is uncovered and understood.

Figure 7.1 shows PaJMa’s multidimensional approach to layering the patient journey model as it appears to the redesign team. The layers are stacked vertically starting with patient movement.

To aid in easy identification of the objects within the layers, each layer uses colour and standard workflow shapes as additional cues. The diagrams described and shown in this research were created using Microsoft Visio®. The names used to describe the shapes are as per that software. Initially the objects used in each layer are defined. All of the layers are then bought together and are demonstrated using the thesis case study.
As part of the modeling activity, the data required to support the implementation of the patient journey also needs to be captured. The individual data attributes for each dimension are detailed in Chapter 8. This data will include a summary of the overall patient journey under review including the estimated number of patients that will undertake this journey in a given period and the time it currently takes for a patient to complete the journey from beginning to end. The data required can be captured during the modeling exercise itself or as part of the model finalisation activity.

Each of the symbols used in the PaJMa layers is now described and discussed.

**Figure 7.1. PaJMa Layers and Description**
7.3.1 Patient Movement and Staff Roles layer
The Patient Movement and Staff Roles layers are used to track patient interactions with staff and movements within and between HCO’s. The patient is uppermost in the model with the staff roles they interact with directly below. Figure 7.2 shows the icons that are used within this layer to define patients and staff roles.

![Figure 7.2. Patient and Staff Role Layer Objects](image)

*Patients* are shown using a *red person figure*. They may be labeled either as just ‘patient’ or as in the case of the midwifery case study, a patient is referred to as a ‘woman’.

It is important that the patient is of a significant colour and is at the top of the model as this helps to keep the focus on the patient, that is, it keeps the models 'patient centered'. Each time a patient interacts with the service, a handover of care is necessary or they are moved from one area to another, a red figure object is placed in the Patient Movement layer. The Patient data described in Chapter 8 are required to be defined as part of each ‘patient’ object.

*The existence of too many red figure objects in this layer may indicate that a patient is required to repeat information multiple times, excessive care handovers are occurring or they are being moved too many times.*

The Staff Roles layer uses different colour person figures for healthcare workers (including clinicians and specialists) and a grey person figure for administration staff. Each different type of healthcare worker (non-administration) that a patient interacts with, is shown in a different colour and is given a unique name. Each time a particular staff role is involved in treating the patient, the same colour person figure and name are used. If multiple healthcare workers are involved in the same episode of care then each staff role will be a different coloured person figure and the
figures are stacked diagonally upwards to the right. The Human Resources data described in Chapter 8 are defined for each ‘Staff Role’ object that is placed on the model.

The existence of too many different staff role coloured person figures may indicate that there are an excessive number of care handovers occurring or the patient is repeating information multiple times.

Figure 7.3 shows an example of the Patient Movement and Staff Roles layer of the PJM from the Midwifery case study described in Chapter 5.

![Figure 7.3. Patient Movement and Staff Role Layer example From Midwifery Case Study](image)

7.3.2 Process layer
The Process layer defines the processes that a patient is involved in as they are treated and moved through the Healthcare Organisation (HCO).

The process data described in chapter 8 are defined for each ‘Process’ object that is placed on the model. The details of human and physical resources required by a process should also be defined as part of the process definition. This involves capture of the ‘Human Resources’ and ‘Physical Resources’ dimension data as per Chapter 8.

Figure 7.4 shows the basic icons that are used when modeling processes. Some of the icons used are similar to those used in general flowcharting techniques and the Business Process Modeling Notation (BPMN) (IHI 2004; Object Management Group 2006).
As one of the key goals of healthcare improvement is to reduce care variability there should not be a requirement to model ‘adhoc’ treatment streams. If this does become a requirement, then a separate PJM must be created and justified.

Processes are depicted using blue rectangles. Each process is numbered and given a descriptive name. Sub-processes are indicated using a ‘+’ sign contained within a small box, located in the bottom centre of the process object. Sub-processes are then modeled on a separate page using the same notation. Process numbering for sub-processes starts with the parent process number followed by a period and then follows standard ascending number order beginning at 1 (ie: 10.1, 10.2 etc.).

Decisions are shown as yellow ‘decision’ diamonds. For each decision there will be a positive and negative possibility. Each exit arrow should be labeled with its positive or negative result, typically using the words ‘yes’ or ‘no’. The result of a decision can lead to the termination of a process or the execution of another process in the journey. Process terminations result in an arrow back to the patient movement layer and a white termination symbol describing the impact on the patient.

Processes are related via the use of single headed arrows for manual linkages or via the use of a ‘lightning bolt’ communication symbol for automated linkages (ie: where information is transmitted between processes via an IT system).
Where a blockage, queue, or patient flow interrupt occurs the linking arrow is replaced by a process flow interrupt symbol. This icon includes a red triangle and an additional small arrow pointing upwards indicating that the patient is being affected by a delay.

The modeling of more complex process flows including parallelism and conditional flows are discussed in section 7.3.6.

### 7.3.3 Information Creation/Update Layer

The *Information Creation/Update* layer shows what documents/forms/charts, information systems, manual storage systems or other communications are created or updated as a consequence of process enactment. For ease of presentation, multiple information icons for a given process are grouped in an unlabeled container.

---

**Figure 7.5. Example of Information Creation/Update Layer Icons**

Information is represented by several icons depending on how the information is created, used, stored or extracted. A green ‘document’ symbol is used for paper, forms, charts etc. and a white ‘system’ symbol for computer input or information extraction. A ‘manual’ operation symbol is used to show details stored on a whiteboard or in a file cabinet etc… If telephone communications are part of the process enactment this is shown as a ‘double phone’ icon. ‘Notes’ relating to items within the ‘Information Creation/Update’ layer can also be added to this layer as an optional item. These are shown as grey oblongs.

Modeling of these objects requires the capture of data for the ‘Administration’ and ‘Technology Support’ dimensions described in Chapter 8.
7.3.4 **Patient Needs/Practice Guidelines/Policy layer**
This layer explicitly relates patient needs, practice guidelines and/or policies to a process. As part of the process definition, the specific patient needs that are required to be catered for must be defined. Patient needs are denoted using an orange rectangle and can be given a ‘tag’ to identify what category of need is being catered for such as religion, cultural etc. Practice guidelines that are to be followed as part of process enactment are also captured, along with individual policies that must be adhered to. This can include state and federal legislation. Practice guideline and policy objects are shown as pink ‘document’ shapes and each item must have a unique name. An example of the objects used in this layer are shown in Figure 7.6.

![Figure 7.6. Patient Needs/Clinical Guidelines/Policy Layer Objects](image)

Modeling of these objects requires the capture of data for the ‘Patient needs’ and ‘Practice Guidelines’ dimensions described in chapter 8. NB: At the operational level, a policy is defined using the same data elements as a practice guideline.

7.3.5 **Measurements layer**
This layer defines the measurement indicators used to: a) assess the level of patient journey improvement that can be attributed to a change and b) monitor ongoing performance to plan. *Actual* values will be captured as part of process enactment and used in future analysis for comparison to *target* values and the identification of variances that may lead to further patient journey improvements.

Measurements do not provide definitive answers; rather they are designed to indicate potential problems that might need addressing, usually demonstrated by statistical outliers or variations within data results. A well designed metric should ‘screen’, ‘flag’ or ‘draw attention to’ a specific issue. Usually rate based, metrics identify the rate of occurrence of an event or the degree of successful outcome (ACHS 1996).
Many types of measurements may be applicable for a given patient journey with clinical indicators being of critical importance.

A *clinical indicator* is a measure of the clinical management and/or outcome of care. Clinical Indicators are best seen as measures that screen for a particular event. The ACHS (2007) states that the aim of clinical indicators is to:

- Increase the involvement of clinicians in evaluation and quality improvement activities.
- Create and provide useful tools to screen, flag or draw attention to potential problems and/or areas for improvement in health care.
- Facilitate the collection of national data on the processes and outcomes of patient care.

The greatest benefit of clinical indicators is derived from their analysis and use at the clinical level to reduce care variability thus improving clinical unit practices and patient safety. The ability to effect improvements in patient care will largely depend on the relevance of the indicators being monitored. To identify those clinical indicators, which are potentially relevant and appropriate, the following points should be considered (ACHS 2007):

- Does the indicator measure an important aspect of clinical practice eg surgical site infection rates or deaths under particular circumstance?
- Will the data collected on this indicator assist in improving clinical care?
- Will the information potentially be useful to clinician’s in demonstrating how the service is performing and ways that it may be improved?
- Do the indicators relate to and support the strategic intent of an organisation?
- Does the organisation provide the service eg. obstetrics, mental health, oncology?
- Does the organisation treat patients within these categories eg. patients presenting with acute myocardial infarction, neonatal transfers to intensive care?
- Are there sufficient numbers of patients within these categories for meaningful data to be obtained?
• Will the data be available and accessible to clinicians to allow for accurate monitoring of the indicator?
• Are existing resources sufficient to allow for effective and ongoing monitoring of the indicator?

These points also highlight a potentially problematic issue that healthcare redesign teams may encounter. That is, the notion that ‘everything must be measured!’ This is not necessarily the case and a measurement should only be defined when it will assist in determining if an implemented improvement is performing as expected. The questions above can also be used to verify if a metric is actually needed in a given situation.

Another critical aspect affecting indicator development is the perceived value and relevance of the indicators attributed to them by physicians, clinicians and administrators; the clear delineation of accountability, organisational support for measurement and reporting and the current organisational culture relating to performance measurement (Lemieux-Charles et al. 2003).

Any indicator defined must be able to be traced back to a strategic objective or the value of the work being conducted should be questioned. Research suggests that clinical and support teams are more likely to make changes when operational measures are formally linked to strategic goals (Lemieux-Charles et al. 2003).

![Figure 7.7. Measurement Icons within PaJMa](image)

Each measurement on the PaJMa model is depicted in a white oblong and each different type of metric is labeled with a unique name. The target value for the measurement is also included (see Figure 7.7). Totals such as patient journey time may be shown in red at the end of the row. As discussed previously, measurements for time and cost must be included as a minimum.
A legend of the basic measurements that would be included on most models is shown in Table 7.1. Others can be defined by the HCO as needed. During development of the Future Patient Journey Model it is highly likely that new metrics will be identified and added to the model. These can be numbered (m1, m2,....mN) in the first instance and are fully described as part of the Measurement Dimension data element definition as per Chapter 8.

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>tpt</td>
<td>Target process time</td>
<td>jt</td>
<td>Total journey time</td>
</tr>
<tr>
<td>#pr</td>
<td>Number of physical resources required (*)</td>
<td>#hr</td>
<td>Number of human resources required (*)</td>
</tr>
<tr>
<td>$pr</td>
<td>Cost of physical resources</td>
<td>$hr</td>
<td>Cost of human resources</td>
</tr>
<tr>
<td>cr</td>
<td>Compliance rate</td>
<td>cfl</td>
<td>Confidence level</td>
</tr>
</tbody>
</table>

Table 7.1. Example Patient Journey Measurement Types

Where multiple items of the same category need to be measured, each is given a unique number. (*) If only one human or physical resource of a particular type is required the ‘#hr/pr’ does not need to be shown. If no ‘#’ is shown the number required is assumed to be one. Where there is more than one human or physical resource required for a process, the codes for the individual items would be shown as per the Table below.

<table>
<thead>
<tr>
<th>Measurement Code</th>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hr1</td>
<td>Human resource role 1</td>
<td>$15.00/hour</td>
</tr>
<tr>
<td>Hr2</td>
<td>Human resource role 2</td>
<td>$30.00/hour</td>
</tr>
<tr>
<td>Hr3</td>
<td>Human resource role 3</td>
<td>$40.00/hour</td>
</tr>
<tr>
<td>Pr1</td>
<td>Physical resource type 1</td>
<td>$48.00/day</td>
</tr>
<tr>
<td>Pr2</td>
<td>Physical resource type 2</td>
<td>$0.20/page</td>
</tr>
</tbody>
</table>

Table 7.2. Unique Identifiers for Measurements within the Same Category

Measurement examples from the Primary Care Midwifery case study are shown in Figure 7.8 and Figure 7.9.
Figure 7.8. Measurement Examples from Midwifery Case Study

Figure 7.8 shows four types of measurements: ‘target process time’, ‘cost of human resources’, ‘number of physical resources’ and ‘cost of physical resources’. There are two types of human and physical resources required, ‘hr1’ and ‘hr2’ and ‘pr1’ and ‘pr2’. There is however only one of each human resource type required for the execution of the related process thus there is no ‘#hr’ shown, as per the modeling rule discussed above. For physical resource type 1 there are two units of this physical resource type required, hence the notation ‘#pr1:2’. There is only one unit of physical resource type 2 required for the execution of the related process, therefore as per the human resource notation, no ‘#pr2’ is needed on the model.

Figure 7.9. Example of Measurement Row Totals

Figure 7.9 shows an example of a Measurement layer row total. Totals can be shown on each page or only on the last page of the complete model. The first total shown depicts the ‘total time to complete the patient journey’ including queue or waiting time. This is usually shown in days but smaller ranges can be used as appropriate. Following this is the ‘target process time’, ‘cost of human resources’ and ‘cost of physical resources’ totals. The figures used in this example would be read as such:

- The total patient journey takes 16 days to complete
- Of this actual time involved in process execution (value-added time) is 115 minutes (the remainder is non-value-added time or wait time)
- The total cost of all human resources involved in the patient journey is $65.60.
The total cost of all physical resources involved in the patient journey is $43.10.

The *measurements dimension* data elements outlined in Chapter 8 must be gathered and documented for each metric placed on the model.

### 7.3.6 Modeling Complex Processes

The objects described above adequately model basic sequential patient flows. It is of course however not uncommon to have processes that occur concurrently or as a result of certain conditions. Such situations require additional modeling notation as shown in Figure 7.10, Figure 7.12 and Figure 7.11. NB: Parts of the notation used are similar to that found within BPMN (Object Management Group 2006).

**Concurrent process flow**

Processes that are required to be executed concurrently use the standard process icon, with all parallel processes being grouped together within a larger unlabeled container. Numbering of the processes within the container is still in ascending order following on sequentially from the calling process. Figure 7.10 shows that at the completion of process ‘1’, two parallel processes are then completed, namely processes numbered ‘2’ and ‘3’ respectively.

![Figure 7.10. Parallel Process Execution (converging to same exit process)](image)

Figure 7.10 models a simple flow of parallel processes, with each process converging to the same ‘exit’ process. If individual or groups of parallel processes exit to different processes, each unique process stream is linked to the calling process using a separate relationship as shown in Figure 7.11.
In this scenario, at the completion of process ‘1’, three parallel processes, namely process ‘2’, ‘3’ and ‘4’ need to be completed. However not all of these parallel processes exit to the same process. Process ‘2’ leads to process ‘5’, with processes ‘3’ and ‘4’ converging to process ‘6’. Thus each patient flow (or stream) is linked to the calling process by a separate arrow. A separate page is used to model each ‘stream’ of parallel processes. For example, process ‘2’ (stream a) will be modeled on page 2, but processes ‘3’ and ‘4’ (stream b) will both be modeled on page 3. If at some point these individual streams converge back to the same flow, they will be related back to the calling page number.

Modeling of parallel processes is done on a new page, separate to the ‘parent’ or ‘calling’ page, using the standard six layers (as in Figure 7.1). The related page number (sequential) is shown beneath the process name. Multiple parallel processes can be shown on the same (but separate) page/screen with each vertical slice, relating to an individual process, being delineated from another using a vertical bold black line. Figure 7.12 demonstrates the modelling and page separation for the parallel process structure from Figure 7.10. A cross reference back to the calling page/screen is included below each parallel process name.
Figure 7.12. Parallel Process Model Definition Delineated with a Vertical Bold Black Line

**Conditional process flow**

Modeling of conditional flows uses a similar modeling notation to that above but with the addition of a conditional decision point. This scenario is shown in Figure 7.13. An arrow exits the ‘calling’ process and is attached to a *conditional decision icon*. Each branch leading from the *decision icon* indicates the execution of a particular process or set of processes based on the meeting of certain conditions. If no specific conditions are met then the ‘*default*’ process is completed. A ‘*default*’ condition is indicated using a diagonal line across the appropriate branch at the end nearest the decision point. Conditional branches can lead to the execution of single sequential processes or groups of parallel processes. The completion of each condition may result in all possible options converging to the same or different exit processes.
Convergence follows the same rules as described in the section on ‘concurrent process flows’ above. The diagrammatical representation of convergence of conditional paths is shown in Figure 7.14. This diagram shows two process paths that were previously split based on a particular condition being bought back into the same mainstream process flow.

7.3.7 Modeling Care Handovers and Discontinuities of Care

Effective care handovers are of critical importance in the efforts to decrease adverse events and increase overall patient satisfaction. The use of Communication Protocols such as ‘Situation-Background-Assessment-Recommendation’ (SBAR) for care handovers can help to minimise errors that result from communication handovers at change of shift or treatment or patient movement. (IHI 2004; Kaiser
Foundation Health Plan Inc 2004). The requirement to complete duplicate paperwork or repeat a problem excessively can also cause patients extreme irritation and raise their level of stress significantly. It is important that discontinuities of care are also modeled as a part of the patient journey. This will ensure that handover points are explicitly defined so that correct and effective communications about important information (including hardcopies) can be implemented.

Where recognised care handovers are necessary or cannot be removed from the process flow, a broken (ie: dashed) bold red vertical line is placed between the two processes where the handover occurs occurs. A major cue to the existence of care handovers is the change of colour of the objects in the staff roles layer. An example PJM showing a recognised care handover is shown in Figure 7.15.

Figure 7.15. PJM Showing a Recognised Care Handover
Discontinuities of care concern the patient’s total disassociation from one healthcare provider to another, across or between processes. For example if a patient is discharged from hospital and there is no information or care plan dispatched to the patient’s local GP or specialist, this is a discontinuity and not a care handover. Discontinuities of care have been shown to increase the chances of adverse events leading to unnecessary intervention and increased costs (Tracy and Tracy 2003).

Discontinuities of care are shown on the patient journey model via the insertion of a bold red unbroken vertical line located between the two processes where the discontinuity occurs. A major cue to the existence of care handovers is the change of colour of staff role objects. An example is shown in Figure 7.16.
The existence of an excessive number of care handovers or discontinuities of care indicates that there is potential for the introduction of adverse events, increased levels of patient dissatisfaction and increased costs.

7.3.8 Slicing and Dicing the Model
A key benefit of PaJMa’s multi-dimensional approach is the ability to view the model from different perspectives based on the interest level and impact on selected stakeholder groups. This is achieved via the selection and display of only certain horizontal or vertical segments of the model. In multi-dimensional database terminology this is known as ‘slicing and dicing’ (Inmon et al. 1999). For example if the JAD sessions mainly involved patients and the staff they interacted with, the presentation of the model layers could be adjusted so as not to overwhelm the group with unfamiliar information. This may see only the patient movement, staff roles and process layers displayed and discussed as in Figure 7.17, thus presenting a limited horizontal slice of the overall patient journey model. Using such an approach simplifies development of the overall patient journey model as it allows the model to be built up progressively over time.

Figure 7.17. Horizontal Slice of Current Patient Journey (Showing Only 3 Layers)
If the group is more concerned with a particular process and how its interactions with other dimensions can be improved, then the model can be sliced vertically as in Figure 7.18. This Figure shows only those objects that are relevant to the process ‘Assign Woman to Midwife’. This includes the staff roles involved, the information captured/updated, associated delays and metrics. Separating the model into vertical slices allows the audience to concentrate on a limited set of information and focus their improvement efforts. This can simplify the identification of journey issues as in this case where it is relatively easy to see that the process is duplicating the capture and storage of information across multiple sources.

Figure 7.18 Vertical Slice of Current Patient Journey Model
7.4 Application of PaJMa to the Case Study

The use of PaJMa is now demonstrated via the Case Study environment as described in Chapter 5. The case study example details the first stage of a woman’s interaction with the primary care midwifery service at Ryde hospital. The general workflow for determining if a woman is a candidate for the Ryde Midwifery Group Practice (RMGP) model is currently manual (Australian College of Midwives 2004; Tracy 2004).

Patient Journey Model development was conducted via facilitated group sessions with the caseload midwives and the maternity management team during the audit process of the Ryde Midwifery Group Practice (Tracy and Hartz 2005). Patient input was in the form of patient satisfaction surveys. Participation in this study by the midwives was totally voluntary and approximately 16 staff participated in the sessions. The sessions discussed the current processes being used and looked to streamlining the patient’s journey by identifying bottlenecks, inefficient use of resources, potential and actual communication breakdowns and unnecessary paperwork. Metrics relating to suggested process improvements were also investigated and documented for on-going measurement and assessment.

The facilitated group sessions occurred on-site at Ryde Hospital once a week for 5 weeks alongside a mandatory audit process. Documentation of the findings and results relating to the current and improved processes were collated and documented off-site at the University of Western Sydney in between group sessions. Ethics approval for theses sessions was obtained from the Northern Sydney Health Human Research Ethics Committee (protocol no. 0608-128M). Project outcomes were presented to the Midwifery team, Hospital management and the Associate Professor of Midwifery who led the initial evaluation process of the Ryde Midwifery Group Practice at Northern Sydney and Central Coast Area Health Service (NSCCAHS) (Tracy and Hartz 2005).

Specific outcomes included:

- The first accurate model of the current journey of a woman through the Ryde Midwifery Group Practice (RMGP);
- A suggested new model describing how the patient flow could be improved;
- A suggested plan of action for implementation of the highlighted improvements;
- Increased awareness, for the involved participants, of the techniques that can be used to redesign patient-centric healthcare processes;
- Dissemination of project experiences and results through publication in leading Health Informatics forums.

7.4.1 Project Startup
As part of the project startup activity, the Healthcare Provider Strategy was reviewed. Strategic objectives relevant to the patient journey under review were extracted and the Balanced Scorecards perspectives and measures confirmed. As part of the Healthcare Improvement project, targets to be met and initiatives to meet the set targets, were defined. If not all of this information is available, the omitted information must be created and confirmed with Executive, as discussed in Chapter 4, prior to development of the patient journey model.

Once the project team understood what goals, measures, targets and initiatives were required, a high level Context Diagram, as used in Constantine and Yourdon’s Data Flow Diagramming technique, (1979) was constructed. A Context Diagram is a high level view of the required system. It shows the system as a whole, along with the interactions to and from these external entities. Context diagrams are used as an aid to gain consensus on the scope of the patient journey modeling exercise and what stakeholders should be involved. Figure 7.19 shows the basic notation used in the development of the context diagram.
The Context Diagram starts with a central named bubble, representing the ‘system’ to be developed. External entities that will interact with the new ‘system’ are drawn as named boxes but outside the ‘system’ bubble. Directional interaction lines connect the ‘system’ to the external entities. Labeling of the interaction lines is optional (Constantine and Yourdon 1979).

The context diagram showing the scope and external entities involved in the case study patient journey modeling activity is shown in Figure 7.20.
As part of the scoping exercise, discussion on patient volumes, involved in the journey under review, are required. It is not unusual that patient traffic will vary over parts of the week or month, creating peaks and troughs in resource usage. This is known as patient variation or variation in patient flow levels (Litvak et al. 2005; Jensen et al. 2006). Although it is accepted that patients will arrive in no known pattern, patient flow is more about looking at how ‘internal organisational jams’ or ‘artificial variation’ can be eliminated. A good example of artificial variation is given in ‘Leadership for Smooth Patient Flow’ (Jensen et al. 2006):

A cardiac surgeon schedules all of his heart surgeries on Tuesdays and Thursdays, usually about 8 cases per day. On each of these days the staff who care for these patients in the ICU post-operatively, are in chaos. This has two key effects: a) the cardiac patients may not get the maximum attention they require and b) other surgical cases requiring ICU care are cancelled or diverted to other facilities. This happens week in and week out but is treated as a crisis each time. Following the ‘peak’ in cardiac patient care, ICU staff are sometimes under-utilised thus creating a ‘trough’ in resource usage.

However if the cardiac surgeon scheduled the same volume of surgeries over four days the surgical flow would be ‘smoothed’ and the ICU staff and resources consistently employed. This would allow more time per patient and leave space for other surgical cases that arrive. This not only smooths the flow of patients but reduces the stress on the staff caring for them.

Research in methods for ‘smoothing’ variation in patient traffic is gaining momentum with key work in statistical analysis techniques being conducted by Litvak et al. (2005; 2005) and the Institute of Healthcare Improvement (IHI 2003; 2007). A number of the techniques being researched are from other service industries and include: Forecasting, Demand-capacity Management, Queuing Theory and the Theory of Constraints (Jensen et al. 2006).

Artificial variation, is a related but separate activity to Patient Journey redesign and should be addressed prior to development of the Patient Journey Models. As discussed in Chapter 1, statistical analysis of patient traffic is outside the scope of this research but it is vital that the redesign team deal with such issues as part of the overall Improvement project.
Once the scope of the patient journey modeling activity is agreed by all stakeholders, development of the current patient journey model can commence.

### 7.4.2 The Current Patient Journey

Figure 7.21, Figure 7.22 and Figure 7.23 show an example of the PaJMa tool in action. These figures detail the Ryde Midwifery Group Practice (RMGP) patient journey from the point of first contact by the woman up to the finalisation of the booking interview between a named midwife and an allocated woman. The ‘current’ model represents the patient journey as it existed at the commencement of the Ryde Audit project. The list describing the measurements types used in the model is shown in Table 7.3.

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>tpt</td>
<td>Target process time</td>
<td>hr</td>
<td>Human resource</td>
</tr>
<tr>
<td>pr</td>
<td>Physical Resource</td>
<td>jt</td>
<td>Total journey Time</td>
</tr>
</tbody>
</table>

Table 7.3. Case Study Measurement Types

The legend for specific measurement items, by code, is contained in the table below.

<table>
<thead>
<tr>
<th>Measurement Code</th>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>hr1</td>
<td>Ward clerk</td>
<td>$15.00/hour</td>
</tr>
<tr>
<td>hr2</td>
<td>Midwife</td>
<td>$30.00/hour</td>
</tr>
<tr>
<td>hr3</td>
<td>NUM</td>
<td>$40.00/hour</td>
</tr>
<tr>
<td>pr1</td>
<td>Std Office w/PC</td>
<td>$48.00/day</td>
</tr>
<tr>
<td>pr2</td>
<td>Phone call</td>
<td>$0.20/call</td>
</tr>
<tr>
<td>pr3</td>
<td>Exam room</td>
<td>$72.00/day</td>
</tr>
</tbody>
</table>

Table 7.4. Case Study Measurement Codes and Staff Roles
7.4.2.1 PaJMa Current Patient Journey

Figure 7.21. RMGP Current Patient Journey Model - p.1
Figure 7.22. RMGP Current Patient Journey Model - p.2
Figure 7.23. RMGP Current Patient Journey Model - p.3
Model Description
The diagrams show several contributing dimensions as outlined in chapter 6. In general the model is read top-down from left to right. The model can also be read as a number of related vertical slices or it can be sliced and diced horizontally to highlight combinations of different parts of a patient’s journey, for example, how many different types of staff a patient has to interact with.

The following is a brief outline of how the model is read. In descriptive terms it is like role-playing a patient’s experience whilst they are within a service. Starting with the patient, the reader moves vertically down the page, progressively building up the relationships between the layers. Once a vertical ‘slice’ is understood, the reader moves onto the next vertical slice, with consideration of how the current process is linked to its predecessor.

The reading of the current patient journey model of the Ryde Midwifery Group Practice (RMGP) depicted on the previous three pages is as follows:

- A woman phones or attends Maternity to gather information about birthing at Ryde

Process 1:
If she wishes to proceed and has a valid Medicare card, an appointment is made for a clerical booking. If the woman has come into Maternity and the ward clerk is available at the time, the clerical booking can be done straight away. If not the woman must come in at another time. This may lead to a delay of up to 2 days depending on the ward clerk’s next available appointment time (and the woman’s availability). The clerical booking involves completion of three (3) forms and creation of a Patient Administration System (PAS) record.

Notes on the PJM highlight that the clerical booking uses 3 forms that are in the main unsuitable to patients entering the RMGP model. The U2AA requires 4 signatures, 2 sections are already in PAS and 2 other sections can be done on form A30. The Inpatient Election form requires 2 signatures, 1 section is not used and other information is already in the Patient Administration System (PAS). The MRN sheet requires 2 signatures, 6 sections are not used and the wording is not suitable for a RMGP patient.
The clerical booking follows the ‘NSCCAH Policy for Patient Admission’. The process takes 20 minutes and requires one Ward Clerk @ $15.00/hour and the use of a standard office with PC @ $40.00/hour.

**Process 2:**
At the next Allocation Meeting, held each Wednesday, the caseload midwives review the paperwork from the clerical bookings to determine which dedicated midwife a woman is to be allocated to. The Nurse Unit Manager (NUM) verifies the allocations and makes adjustments if necessary. The allocation information is written in 4 places. A whiteboard showing details of each caseload midwife’s current allocations and expected absences, the Bookings Book (black) kept on the ward, Bookings Folder (purple) kept in the clinic and the allocated midwife’s personal diary. This process takes 5 minutes to complete for each woman and requires the use of two types of human resources namely 5 midwives and 1 NUM. A standard office space is also required. The total Human and Physical Resource cost per allocation is $15.85 and $0.15 respectively.

**Process 3:**
The dedicated midwife rings her allocated woman to make a Booking Interview Appointment. The appointment time is recorded in the midwife’s personal diary, the Clinic Diary and the Bookings Folder (purple). This process takes 5 minutes to complete for each woman and requires a telephone and standard office space. Process 3 costs $2.50 and $0.30 in Human and Physical Resources. NB: (The remaining processes are all completed by the woman’s dedicated midwife and require the use of an examination room).

**Process 4:**
The woman arrives at Ryde for the Booking Interview with her dedicated midwife. The woman gives/receives general information and advice about her pregnancy. Any existing pathology or ultrasounds are also reviewed and the woman’s PAS record details confirmed. The process follows the National Midwifery Guidelines, takes 10 minutes to complete and costs a total of $10.00 per Booking Interview.
Process 5:
The RMGP model is outlined and various care options discussed. This includes providing the woman with relevant literature and available handouts. The process follows the National Midwifery Guidelines and takes 10 minutes to complete at a cost of $10.00.

- The woman is asked if she understands the scope of the services offered and if she wishes to continue with the booking. If she does not wish to continue she is advised to book elsewhere and the journey terminates.

Process 6:
Continuation requires the collection and recording of a full medical history. This information is collected and entered into OBSTET, details are added to a H35 and the woman’s antenatal notes. The process takes 30 minutes to complete at a total cost of $20.00.

Process 7:
Following collection of a full medical history, the woman’s suitability for the RMGP model is assessed. The process follows the National Midwifery Guidelines and takes 5 minutes to complete. Process cost is $5.00. If the woman is unsuitable she is advised to book elsewhere and the journey terminates.

Process 8:
If the woman is suitable, referrals for pathology, Nuchal Translucency Screening or dating ultrasounds are now prepared (if needed). The process takes 5 minutes and costs $5.00.

- The midwife now decides if a Domestic Violence screening can be conducted at this visit. Under the Domestic Violence (DV) policy, a woman can only be screened if she is alone (children under 3/interpreter permitted). If the woman’s is not alone or her partner gets upset when asked to leave the room the midwife may decide to postpone the screening until the next visit and annotates the antenatal notes accordingly.
Process 9:
If a DV screening is completed details are recorded in the antenatal notes and on the relevant DV forms. An Area Statistics Policy also applies to aspects of the DV Screening data. This process takes 3 minutes to complete at a cost of $3.00.

Process 10:
A physical exam of the woman is conducted. This includes blood pressure readings, fundal height palpitation and breast examination. The timings for pregnancy progress and antenatal visits are outlined. This follows the National Midwifery Guidelines, takes 5 minutes and costs $5.00.

Process 11:
Finalising the booking involves a number of sub-processes.
  - Making the next antenatal appointment, recording the appointment on the woman’s yellow card, adding the appointment to the clinic diary and the midwife’s personal diary. Contact information is also added to the woman’s Yellow Card at this time.
  - Completing and printing OBSTET input.
  - Collating the clerical notes, H35 and any previous medical record details to create an antenatal notes file. Placing a sticker on the notes and filing them.

The combination of sub-processes takes 10 minutes to complete and costs $10.00.

The total value added time is 115 minutes but elapsed time may extend to 16 days depending on when the woman attends the service and if staff are available. The costs of human and physical resources consumed for the complete patient journey are $65.60 and $43.10 respectively. It must be highlighted that these figures represent only one woman’s journey through the RMGP model. Ultimately these figures would need to be extrapolated to cover the total number of woman expected to use the service over a given time period, for example, 240 woman birthing per year.
7.4.2.2 Issues Identified

The description of the model clearly depicts where wastage, duplication and time delays are occurring and sets the scene for clear plans of action to be put in place. The issues below have been highlighted in Figure 7.21, Figure 7.22 and Figure 7.23 respectively using a red asterisk with a corresponding number.

1. The woman may not be assessed as to her suitability for the RMGP model until her 3rd visit to Ryde. *1
2. Three (3) forms are used for the current clerical booking; 8 signatures are required, 7 sections on these forms are unused or worded incorrectly for the Ryde model, 4 sections are duplicated across the PAS and other forms. *2
3. Booking information is duplicated across several mediums (ie: booking books/whiteboard). *3
4. It may be over 1 week after the women has completed her clerical booking before she is contacted by a midwife to make a booking interview. *4
5. The midwife’s and the woman’s time is wasted and redundant paperwork is completed if the woman is assessed as being unsuitable for the RMGP model at the Booking Interview. *5
6. Domestic Violence screenings are not always completed as per Policy. *6
7. The total actual patient processing time is 115 minutes. Elapsed time however is variable and may extend to 16 days depending on when the woman actually attends Ryde for her clerical booking and her details are placed in the Booking Book for allocation. *7

Impact on Patients and Staff

As a result of the above issues, there are several impacts on both the women and staff treating them. These include:

- If the woman has attended Maternity to make a clerical booking, completed the clerical booking and then during the booking interview is assessed as being unsuitable for the RMGP model she may get quite upset and frustrated. This will give her a negative attitude of the service and she may pass this perception onto others. A potential reason for birthing numbers and patient satisfaction levels to decrease.
This situation may also have necessitated in the woman taking time off work on three separate occasions. She will now have to take more time off to complete another booking process at the new hospital, another negative effect on the patient and their satisfaction levels.

If the woman is assessed as being unsuitable for the RMGP model, all paperwork prepared in the first stage of the Booking Interview becomes redundant. Other hospitals have different booking procedures or would prefer to complete the paperwork from scratch during their own interview process.

Allocation details are replicated across 4 mediums. This increases the amount paperwork and time required of the midwives. A review of how these details can be stored more economically is required.

Some midwives complete OBSTET input during the Booking Interview which interrupts the face-to-face contact with the woman.

Domestic Violence screenings are sometimes not completed if the midwife feels uncomfortable asking the partner to leave or if she feels he may become upset if asked to leave. It has been confirmed that the Domestic Violence (DV) Policy states it is mandatory for the DV screening to be completed on the first visit and the woman must be alone (children under 3 and/or an interpreter are permitted to be present). If the DV screening cannot be completed a separate section of the form must state the reasons why the screening was not conducted and it must be noted that the screening is required at the next visit. Failure to conduct the DV screening leaves Ryde open to potential litigation if the woman does have domestic violence issues and she and/or the unborn baby are harmed during the pregnancy.

Based on the above issues and impacts, highlighted by the development of the current patient journey model, an improved patient journey was designed. This is known as the Future Patient Journey and uses the same PJM development principles and notation as the Current Patient Journey.
7.4.3 The Future Patient Journey

The Future Patient Journey Model represents a view of how the current patient journey can be enhanced to provide reduced care variations thus delivering higher levels of quality care, increased patient safety and satisfaction, maximising the value of the resources involved and the capture metrics for on-going monitoring and analysis.

Initially the issues and impacts identified in the Current Patient Journey Model are interrogated and the involved stakeholders determine how these areas are to be redesigned. The redesigned flow is then modeled using the same PaJMa architecture. Further reviews and changes may follow as the model is verified and validated.

It is at this point that Simulation Modeling tools may be of benefit. Such tools can be used to evaluate problem solution alternatives and to assess the impact each alternative may have on the Future Patient Journey. As discussed in Chapter 1 Simulation Modeling is however outside the scope of this thesis. Research on Simulation Modeling in healthcare is well covered by publications by Brailsford (2005), Klein et al. and Harper and Gamlin (2003) as a small example.

The Future Patient Journey Model for the case study is presented in Figure 7.24, Figure 7.25 and Figure 7.26. Details regarding specific improvements and their impact on women and staff are discussed first. The full model will then be described.

7.4.3.1 Impact of Improvements on Patients and Staff

- A new Assessment Questionnaire (A.Q.) was designed by the midwives and NUM to capture details pertinent to a woman’s assessment for the service, including individual and family medical history and pregnancy history. This can be sent to the woman, as part of the Information Pack (see below), for completion at home in her own time or she can complete it online via the new Ryde Maternity website (see below).
- A new Ryde Maternity Information Pack was created. The pack can be mailed to a woman who is interested in booking at Ryde negating the need
for the woman to attend the hospital for a clerical booking. The information pack contains a covering letter, an Easy Hang Reference Guide, a ‘Giving Birth at Ryde’ brochure and a new Assessment Questionnaire (with a pre-stamped return envelope).

- As a complimentary patient service to the Information Pack above, a new Ryde Maternity website will also be created. The website will contain the same information as the Information Pack with the ability to complete and submit the new Assessment Questionnaire online (see below).

- A new Ryde Maternity Data Base (RMDB) will be developed. This database will hold all maternity patient information and thus serve as a single source of data input, extraction and reporting. The system will be integrated with PAS and OBSTET to allow electronic transfer of data between the systems as required. With the introduction of the Assessment Questionnaire, the majority of the women’s medical history will already be captured and input to the new Ryde Maternity database prior to the woman attending her Booking Interview (if she is suitable). This means that very little data input is needed during the Booking Interview itself, giving more quality time for face-to-face service delivery.

- Once the questionnaire is returned (via a pre-stamped envelope or submitted online), the woman’s responses are used to assess the woman’s suitability for the RMGP model. This means that a woman does not need to attend Ryde at all if she is assessed as being unsuitable.

- The woman no longer needs to attend Ryde for a clerical booking. Based on the uniqueness of the RMGP model, Hospital Administration were approached to redesign the admission procedure for Ryde maternity patients. This has resulted in a total redesign of the admission form down to one page (with one signature) and wording now appropriate for the primary care maternity service offered. The new admission form is completed when the woman presents to give birth (and therefore to be admitted) at Ryde. NB: The woman’s name and DOB will be entered into the Database and an MRN generated for the woman’s file, as part of the Assessment process (see below).
• This change also contributed in part to the position of the maternity ward clerk being made redundant. This is mainly due to other administrative changes that will occur as part of ongoing hospital wide changes but due to the significant redesign of these processes, the need for this position as part of this journey could not be justified on an on-going basis.

• The proposed Assessment Questionnaire reduces the amount of redundant paperwork completed. This is due to the fact that the woman’s suitability is assessed much earlier. It is also a valuable resource for any future booking hospital as all information contained is relevant to any maternity booking procedure.

• New strategies for improving compliance with the Domestic Violence policy will be introduced. This includes setting up a separate area for height and weight checks. When the woman and midwife have left the room to do these checks, the midwife will then run through the Domestic Violence (DV) questions with the woman. This presents a perfectly valid reason for leaving the room and allows increased compliance with the DV policy. This strategy should alleviate any suspicion from an abusive partner as if the woman’s partner asks her what went on whilst she was out of the room, she can be quite truthful about having her height and weight checked. It also allows the hospital to reduce their risk of litigation from policy non-conformance.

• Fourteen new metrics will be introduced to allow better tracking of performance and to permit the RMGP model to be benchmarked and measured against similar primary-care maternity models.

• It is anticipated that patient satisfaction levels will increase due to ready availability of more patient friendly information. In addition with the new Assessment Questionnaire, suitability decisions can be made much earlier in the patient’s journey and women deemed as unsuitable (too high a risk) can seek alternative care before unnecessary absences from work are taken.

• The total journey time has been halved to 8 days, with processing time reduced to 72 minutes, down by 42 minutes. The majority of this time is now value-added time with the woman during the actual booking interview. Human resource costs have been reduced by 53%, with physical resource costs down by 31%
7.4.3.2 PaJMa Future Patient Journey

Figure 7.24. RMGP Future Patient Journey Model - p.1
Figure 7.25. RMGP Future Patient Journey Model - p.2
Model Description

A woman makes an enquiry about maternity services at Ryde. This can be via phone or in person with the ward midwife. A check is done to determine if the woman has a valid Medicare card. If no, exit the journey and advise the woman that she is unable to participate in this service. If the woman does have a valid Medicare card and wants more information, she is either given/sent an Information Pack (processes 1, 3 & 4) or directed to a new Ryde Maternity website (processes 2 & 5).

A new metric capturing how many enquiries are made (m1) is established.

Process 1, 3 & 4:

If the woman does not have Internet access, she is given or sent an Information Pack, containing brochures about the RMGP model and an Assessment Questionnaire.

If after reviewing the information, the woman wishes to make a booking at Ryde, she completes an Assessment Questionnaire (A.Q.), detailing her demographics and personal and family medical history, at her convenience. The paper copy A.Q. is mailed back to Ryde in the pre-stamped envelope and the woman’s responses are entered into the new Ryde Maternity Data Base (RMDB). There may be a delay of up to ½ day from the time the paper copy A.Q. is received and the time it is input by a midwife. This will depend on the midwife’s availability.

New metrics capturing how many Information Packs are sent out (m2) and how many paper copy A.Q.’s are submitted (m5) are introduced.

Process 2 & 5:

If the woman has internet access she is directed to the Ryde Maternity website. The website contains the same information as the above information pack. An internet connected PC is available onsite at Maternity or the woman can view the website from another Internet connected PC (ie: at home), at her convenience. If after reviewing the information, the woman wishes to make a booking at Ryde, she enters her Medicare Card details and completes the online A.Q. It is then electronically transmitted to the RMDB and an alert is posted to the online Midwife message board advising an assessment is required. The next available midwife logs on and makes the
assessment. There may be a delay of up to ½ day from the time an A.Q. is submitted online and the time it is reviewed by a midwife. This will depend on the availability of a midwife. NB: The ½ day delay can only exist in one conditional stream per patient journey. The woman can also print a copy for her records.

New metrics capturing how many website hits (m3) and how many online submissions are received (m4) are established.

**Process 6:**

New A.Q. submissions are reviewed by a midwife and a decision on the woman’s suitability is made. If the woman is unsuitable, a reason is placed on her record and she is contacted by phone. The reasons for her exclusion are discussed and she is advised of her other birthing options. She is also advised to take her completed A.Q. with her as a good source of information for the next hospital. Additional metrics for the total number of assessments received (m6) and how many suitable (m7) or unsuitable (m8) decisions are made, are also recorded.

**Process 7:**

If suitable the woman’s record is noted as such and her details are electronically transferred to PAS and OBSTET (an MRN is generated as part of this process). The system also makes a preliminary allocation of the woman to a dedicated midwife. This allocation is based on pre-determined business rules and existing midwife bookings recorded in the RMDB. The preliminary midwife allocations are emailed to the NUM for review and approval.

**Process 8:**

The NUM reviews the preliminary allocation sent via email and amends or confirms midwife allocations. There may be up to a ½ day delay between the email arriving and approvals being conducted. This is only due to the NUM’s availability, if she is free at the time the email arrives, approvals can be conducted straight away. Final approved allocations are emailed to the relevant midwives for entry into their individual diaries. Final approved allocations are stored in the RMDB. Metrics capturing the number of woman per midwife (m9) and the estimated number of births (m10) are automatically recorded.
Process 9:
The allocated midwife contacts the woman for a Booking Interview. There may be a delay of between 1-5 days before the Booking Interview takes place due to the woman and/or midwife’s availability. The appointment is recorded in the RMDB and the midwife’s personal diary. If an interpreter is required appropriate arrangements are also made. A metric capturing the number and type of interpreters required is introduced (m11).

Process 10:
When the woman attends for her Booking Interview, her assessment questionnaire is reviewed and additional medical history is gathered (if needed). Following collection of any additional medical history, the woman’s suitability for the RMGP model is confirmed. If previously undisclosed information comes to light that impacts the woman’s suitability, she may be advised to book elsewhere at this point. The midwives have set a confidence rate of 90% on original assessments. A metric capturing the number of woman rejected at Booking Interview time is introduced (m12).

Process 11:
If the woman requires referrals for pathology, Nuchal Translucency Screening or dating ultrasounds etc., these are now prepared and details recorded in the RMDB.

Process 12:
A Domestic Violence (DV) screening should now be conducted. New procedures (see ‘improvement and impact’ section above) have been introduced to increase compliance to the DV policy. Metrics capturing the number of DV screenings completed and the number not completed at the first visit are introduced (m13, m14).

Process 13:
A physical exam of the woman is conducted. This includes blood pressure readings, fundal height palpitation and breast examination. Details are recorded on the woman’s yellow card and in the RMDB.
Process 14:
The booking is then finalised. Finalising the booking involves a number of sub-processes.

- Making the next antenatal appointment, recording it on the woman’s yellow card, adding the appointment to the RMDB and the midwife’s personal diary. Contact information is also added to the woman’s Yellow Card at this time. The woman now leaves and the remaining in-house procedures are completed.
- Electronically updating OBSTET and printing relevant OBSTET reports.
- Collating the antenatal notes, including the A.Q., H35 and any previous medical record details and creating an antenatal file. Placing a sticker on the notes and filing them.

7.4.3.3 New Measurements
The table below summarises the newly identified metrics for the future patient journey, by measurement code (as discussed above). In addition to these specific measurements, standard measurements such as actual process time, actual wait time will be captured as part of process enactment.

<table>
<thead>
<tr>
<th>Measurement Code</th>
<th>Description</th>
<th>Measurement Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>m1</td>
<td># of enquiries</td>
<td>m8</td>
<td># rejections at original assessment</td>
</tr>
<tr>
<td>m2</td>
<td># info packs sent</td>
<td>m9</td>
<td># women/midwife</td>
</tr>
<tr>
<td>m3</td>
<td># website hits</td>
<td>m10</td>
<td># estimated births/year</td>
</tr>
<tr>
<td>m4</td>
<td># online AQ submissions</td>
<td>m11</td>
<td># and type of interpreters required</td>
</tr>
<tr>
<td>m5</td>
<td># papercopy AQ submissions</td>
<td>m12</td>
<td># rejections at booking interview</td>
</tr>
<tr>
<td>m6</td>
<td># assessments made</td>
<td>m13</td>
<td># DV screenings completed</td>
</tr>
<tr>
<td>m7</td>
<td># suitable women</td>
<td>m14</td>
<td># DV not completed 1st visit</td>
</tr>
</tbody>
</table>

Table 7.5. Future Patient Journey Measurement Summary
7.4.4 Stakeholder Experience with the PaJMa Tool

Following completion of the Patient Journey Modeling activity a debriefing session was held with the project stakeholders. This session highlighted a number of interesting issues regarding the use of PaJMa as a Healthcare Improvement tool.

- Several iterations of the future patient journey model (FPJM) were required until the Redesign Team were satisfied with the FPJM. On at least 2 occasions the group felt as if the processes had been defined correctly but it was only when they could see the picture of the complete journey was it clear that some changes were not in the best interests of the woman or were impractical at an operational level.

- Although it was not a primary goal of this exercise to reduce the time taken for a booking interview, by improving the efficiency of the patient’s journey it has been possible to reduce the patient journey by 42 minutes. The majority of the remaining time is now value added face-to-face time with the woman during the Booking Interview.

- The new Information Pack and Website were designed by the Midwives with patient feedback.

- The Midwives also designed the new Assessment Questionnaire (A.Q.). It enables the woman to complete details about herself, her past medical history and the current pregnancy at home without the need to come into Maternity. The midwives have set a 90% confidence rate on assessment decisions made at original assessment using the A.Q. It is also suggested that the A.Q. be printed double-sided and replicated in the most common foreign languages of the RMGP’s catchment area. *NB: The Questionnaire may require further enhancements following implementation based on information provided by the woman and accuracy of the assessments made.*

- The proposed assessment questionnaire allows OBSTET to be completed prior to the woman attending her Booking Interview thus increasing the face-to-face contact during the booking interview itself. This was seen by the midwives as a key quality of service improvement.

- The stakeholder team exhibited strong stakeholder buy-in during the Improvement project, in particular the Midwives. Significant enhancements to the current patient journey were actively designed by the whole team and it
was not unusual to see one of the stakeholders take the pen and update the model on the whiteboard. The future patient journey became a frequent item of discussion at team meetings and in general ward conversations. The tool also encouraged group communication, promoting ownership of problems and their solutions. Feedback indicated that the stakeholders felt the models captured the complexity and nuances involved in improving the patient journey. They found the models quick to develop and easy to understand and that they allowed for simple identification of required action plans regarding implementation of the future patient journey.

### 7.5 Assessing the PaJMa Tool

The *Process Modeling Assessment Framework for Healthcare (PMAF4HC)* described in Chapter 5 is now used to assess the PaJMa tool (see Table 7.6). The assessment results are discussed following the Table.

<table>
<thead>
<tr>
<th>Id</th>
<th>Short Description</th>
<th>PaJMa</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPS1</td>
<td>Healthcare Strategy Defn</td>
<td>Yes</td>
</tr>
<tr>
<td>HPS2</td>
<td>Strategic Objectives Defn</td>
<td>Yes</td>
</tr>
<tr>
<td>HPS3</td>
<td>Include Objs on Model</td>
<td>Via link to operational metrics</td>
</tr>
<tr>
<td>PJM1</td>
<td>Domain Specific Model</td>
<td>Yes</td>
</tr>
<tr>
<td>PJM2</td>
<td>Meaningful HC lang/notation</td>
<td>Yes</td>
</tr>
<tr>
<td>PJM3</td>
<td>Degree of Intuitiveness</td>
<td>High</td>
</tr>
<tr>
<td>PJM4</td>
<td>Multi-dimensional Rels</td>
<td>Yes</td>
</tr>
<tr>
<td>PJM5</td>
<td>Hierarchical Process Defn</td>
<td>Yes</td>
</tr>
<tr>
<td>PJM6</td>
<td>Data flows</td>
<td>Yes</td>
</tr>
<tr>
<td>PJM7</td>
<td>Conditional Paths</td>
<td>Yes</td>
</tr>
<tr>
<td>PJM8</td>
<td>Process Fallout</td>
<td>Explicit</td>
</tr>
<tr>
<td>PJM9</td>
<td>Flow of Control</td>
<td>Explicit</td>
</tr>
<tr>
<td>PJM10</td>
<td>Process Completion Times</td>
<td>Yes</td>
</tr>
<tr>
<td>PJM11</td>
<td>Other Process Metrics</td>
<td>Included</td>
</tr>
<tr>
<td>PJM12</td>
<td>Discontinuity of Care/Care Handover</td>
<td>Yes</td>
</tr>
<tr>
<td>HR1</td>
<td>Internal/External Roles</td>
<td>Yes</td>
</tr>
<tr>
<td>HR2</td>
<td>Role Linked to Process</td>
<td>Yes</td>
</tr>
<tr>
<td>HR3</td>
<td>Role Skill Type/Level</td>
<td>Yes</td>
</tr>
<tr>
<td>HR4</td>
<td>Org Structure Defn</td>
<td>Yes</td>
</tr>
<tr>
<td>HR5</td>
<td>Roles on Model</td>
<td>Yes</td>
</tr>
<tr>
<td>HR6</td>
<td>Differentiation of Roles</td>
<td>Yes</td>
</tr>
<tr>
<td>PR1</td>
<td>Physical Resource by Proc</td>
<td>Yes</td>
</tr>
<tr>
<td>PR2</td>
<td>Physical Res Responsibility</td>
<td>Yes</td>
</tr>
</tbody>
</table>
The Assessment results in Table 7.6 shows that PaJMa addresses all of the listed requirements as outlined by PMAF4HC in Chapter 5. This indicates that PaJMa provides substantial benefits over the predominant process modelling tools currently used within the healthcare domain. Specific areas not previously catered for include Healthcare Provider Strategy links to operational processes and metrics, explicit definition of Patient Needs, linking of Practice Guidelines to individual workflow activities and explicit modelling of care handovers and discontinuities of care. More importantly all of this is dealt with on the one model with no need to include ‘add-on’ tools. This suggests that PaJMa presents significant opportunities to the current healthcare improvement environment and should be considered as a serious replacement for the incumbent tools.

### Table 7.6. PaJMa Assessment Results

<table>
<thead>
<tr>
<th>Id</th>
<th>Short Description</th>
<th>PaJMa</th>
</tr>
</thead>
<tbody>
<tr>
<td>PN1</td>
<td>Socio/economic Needs Defn</td>
<td>Yes</td>
</tr>
<tr>
<td>PN2</td>
<td>Cultural/religious Needs Defn</td>
<td>Yes</td>
</tr>
<tr>
<td>PN3</td>
<td>Needs on Model</td>
<td>Yes</td>
</tr>
<tr>
<td>A1</td>
<td>Policy/Guideline Defn</td>
<td>Yes</td>
</tr>
<tr>
<td>A2</td>
<td>Policy/Guideline on Model</td>
<td>Yes</td>
</tr>
<tr>
<td>PC1</td>
<td>Practice G/L linked to Process</td>
<td>Yes</td>
</tr>
<tr>
<td>SD1</td>
<td>Process Data Reqs Defn</td>
<td>Yes</td>
</tr>
<tr>
<td>SD2</td>
<td>IS to Process Rel</td>
<td>Yes</td>
</tr>
<tr>
<td>SD3</td>
<td>Information Flows on Model</td>
<td>Explicit</td>
</tr>
<tr>
<td>M1</td>
<td>Link to Strategic Objs</td>
<td>Yes</td>
</tr>
<tr>
<td>M2</td>
<td>Measurements on Model</td>
<td>Operational</td>
</tr>
<tr>
<td>TS1</td>
<td>Software Support</td>
<td>Prototype</td>
</tr>
<tr>
<td>TS2</td>
<td>Output Workflow Defns</td>
<td>Manual</td>
</tr>
<tr>
<td>TS3</td>
<td>Output DSS Algorithms</td>
<td>Manual</td>
</tr>
</tbody>
</table>

### 7.6 Conclusion

The PaJMa tool presented in this Chapter has been designed specifically for the healthcare domain and draws on the Patient Journey Modeling Meta-Methodology (PJM³) and the Process Modeling Assessment Framework for Healthcare (PMAF4HC) for its basic structure. The multi-dimensional approach used in the model is derived directly from the Patient Journey Modeling Conceptual Design (PJM²) discussed in Chapter 6. The tool architecture utilises techniques from several disciplines including operational research, computer science, business and management and healthcare quality improvement. Initial results indicate that the use
of the tool can improve the patient journey modeling process and the overall quality improvement outcomes.

The key benefits of *PaJMa* are that it contains information relevant to improving patient journeys across a range of dimensions including staff roles involved, processes enacted, information created and updated, patient needs, practice guidelines and policies, and measurement of all required items. These features provide a solution to research hypotheses 2 and 3.

In addition the model can be developed and read in a number of ways depending on the stakeholder audience. This includes developing and reading the model as a number of vertical slices, each showing how the patient is affected by all of the dimensions at one point in time. Alternatively the model can be developed and read as horizontal slices showing the involvement of (for example) patients with staff and the processes they interact with across a time continuum.

Use of the tool in the case study environment demonstrated that the tool copes with the complexities involved in healthcare improvement. It also encourages group communication, is quickly developed and easy to understand, promotes ownership of problems and their solutions and allows for simple identification of required action plans. These are all critical factors in the actualisation of healthcare quality improvements.

Benefits of the new tool are also confirmed via its evaluation using the *Process Modeling Assessment Framework for Healthcare* as discussed in Chapter 5. The evaluation showed that *PaJMa* is a significant improvement on the incumbent process modelling tools being used in healthcare and this provides increased support for its urgent adoption within the healthcare improvement arena.
CHAPTER 8
TECHNOLOGY SUPPORT

8.1 Introduction

“In the Information Age, businesses must increasingly create and deploy intangible assets – for instance, customer relationships, employee skills and knowledge, information technologies; and a corporate culture that encourages innovation, problem solving and general organisational improvements (Kaplan and Norton 2000, p.168).”

In addition to the observation provided by Kaplan and Norton, it is important to note that value does not exist in any one intangible asset. It arises from the entire spectrum of assets and the strategy that is developed to inter-relate them (Kaplan and Norton 2000). The recognition that both tangible and intangible assets are of value is of significance to healthcare, where ‘success’ regularly depends on the skills of the healthcare workers and their application of these skills in a given environment. The identification and inter-relationship of the tangible and intangible assets of a Health Care Organisation (HCO) are highlighted in the development of the patient journey model (PJM). Finalisation of the future PJM (the ‘to-be’ model), leads to an investigation of opportunities to enable the new workflows via the use of supporting technology.

This chapter describes a number of readily available technologies that can be leveraged to provide implementation support for different aspects of the redesigned patient journey. Adaptation of these technologies to the patient journey modeling problem domain provides a solution to research hypothesis 4 as in Chapter 1.
Initially the Patient Journey Modeling Meta-Methodology ($PJM^3$) is revisited to position it within the context of the technical solution space. The relationship between the logical and physical Patient Journey Model environments is then established. Following this the first of a range of enabling technologies, XML, is introduced. This includes definition of the explicit links between the core components of the Patient Journey Modeling Meta-Methodology ($PJM^3$) required to track and automate identified work flows.

Next a supporting multi-dimensional database structure is introduced for the purposes of management decision support in relation to variance analysis and performance and effectiveness monitoring of the redesigned patient journey. This will encompass the minimum data element sets that must be collected as part of the patient journey modeling exercise to support database implementation. An example SQL query and resulting variance report are also presented.

### 8.2 $PJM^3$ and its Impact on the Technology Solution Space

Patient journey models are part of a complex and highly inter-related set of workflows and procedures, involving many stakeholders. When developing the patient journey model multiple dimensions associated with the patient’s movement through the Health Care Organisation (HCO) must be analysed and it is only through the consideration of the inter-relationships and interactivity of all of these dimensions, that a complete and accurate picture of the patient journey can be realised.

The inter-relationships and interactivity of these relationships were discussed in Chapter 4 as part of $PJM^3$. Chapter 6 then discussed a Multi-Dimensional Patient Journey Modeling Conceptual Design that is directly abstracted from $PJM^3$. This conceptual design, $PJM^2$ was then used as the foundation for the development of a new purpose-built multi-dimensional patient journey modeling tool, PaJMa. Such an approach indicates that when assessing the use of technology to support the implementation of new patient journeys, developers must be cognisant of not only the operational patient journey requirements but also the relationships between the high level components represented in $PJM^3$. 

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Figure 8.1 re-presents $PJM^3$ for the purposes of outlining the components that must be supported and linked by the technology being considered as part of patient journey implementation and execution.

Specifically support is required to capture the strategy details of the healthcare provider. These must be able to be explicitly linked to the ensuing patient journey model, particularly in relation to the linking of target process measurements at the operational level. As part of workflow enactment, actual performance measurements must be gathered. These are then relayed to a management decision support system for comparison to the original targets. Variances are analysed and management decisions made as to the need for additional patient journey model improvements or strategic variations.
8.2.1 The Relationship of Logical to Physical Patient Journey Models

Development of patient journey models and the decisions regarding implementation of the models is conducted in two distinct activities. Firstly the details of what needs to occur, who is involved in these activities and when and where they should happen are captured. This is known as a *logical model* as it describes the logical occurrence of items without any restrictions regarding how they will be implemented or with what technology.

Following development of a logical model, details of how the logical model will be implemented are added. This includes what programming languages, database systems and overall architectures will be used. This more comprehensive model is known as the *physical model*. Primary input to the *logical models* is provided by the people who understand the system requirements and who will ultimately use the system. Primary input to the *physical model* comes from the IT staff that will construct, implement and maintain the required systems. Figure 8.2 shows the relationship of the logical to physical model development.

As discussed in Chapter 3, *PJM*³, *PJM*² and *PaJaMa* all deal with the *logical model* of the *patient journey* rather than the physical solution aspects. *Physical model* requirements are added by IT professionals at a later date as part of the implementation design of the future patient journey model workflows and supporting systems.
The remainder of this chapter discusses aspects relating to the development of the *Physical Model*, in particular the technology to be used to communicate data between core components and the structure of a multi-dimensional management decision support system database.

### 8.3 Patient Journey Model Development

The *PaJMa* models presented in Chapter 7 were created using *Microsoft Visio*© which was an ideal medium for prototyping the *PaJMa* architecture concepts and notation sets. Further analysis is required to determine *Visio’s*© capabilities for explicitly linking the individual components of *PJM*³ and the transfer of selected data items between components (ie: Balanced Scorecards from the Healthcare Provider Strategy to Patient Journey Model). Such features should also be able to generate the XML as described in section 8.5, directly from the process definitions developed as part of the Patient Journey Model. An additional requirement would include the generation of executable language programs such as Business Process Execution Language (BPEL) directly from the XML for implementation of automated workflows.

An example of a tool in the *business process* modeling environment is the Rational Rose suite from IBM (2007).

Further analysis regarding extending *Microsoft Visio*© or the development of a new tool to accommodate all aspects of *PJM*³ and *PaJMa* are discussed in the Future Work section of the thesis conclusion.

### 8.4 Workflow Engine

In this research automation of selected workflows will be via implementation on a workflow management system. Workflows are initially defined in XML (as discussed in section 8.5.2). They can then be implemented using an executable language via the workflow engine. Workflow enactment will be conducted by the workflow engine and other system interactions are managed by the workflow management system.
Selection of a workflow management system and execution engine is outside the scope of this research and should be decided in consultation with the Providers IT Support.

8.5 Data Integration and Transfer

As discussed in Chapter 4 this research requires explicit links to integrate and transfer data between the Healthcare Provider Strategy, Patient Journey Model, Workflow and Decision Support System components of the Patient Journey Modeling Meta-Methodology (PJM³). The eXtensible Markup Language (XML) is a widely used technology for facilitating such data transportation and more recently enhanced versions of XML have been specifically defined to transport information concerning Balanced Scorecards, Business Processes and Workflows (Balanced Scorecard Collaborative 2001; McGregor 2002; WfMC 2005; W3C 2006). McGregor’s (2002) IW-MONS Methodology laid solid foundations for a framework for data transfer and integration within a business process modeling environment. My research looks to apply several of the IW-MONS concepts to the healthcare domain via the PJM³ architecture. A number of enhancements were required to the IW-MONS concepts to accommodate the demands of the healthcare environment and these are discussed in the following sections.

8.5.1 Healthcare Provider Balanced Scorecards

This research uses the BSC XML Draft Standard, as developed by the Balanced Scorecard Collaborative (2001), to facilitate the link between the Healthcare Provider Strategy and the Patient Journey Model components. Additional augmentations as defined by McGregor (2002) have also been used as part of the BSC XML within this research. The specification of the Healthcare Provider Strategy in BSC XML allows the particular objectives for a given perspective and section of the patient journey model to be defined. Explicit measurements for each objective are also included, along with the ‘type’ of measurement, ‘unit’ and ‘target value’. For example, the objectives involved in the conduct of an ‘Initial Patient Suitability Assessment’ for the Ryde Midwifery Group Practice (RMGP) model of care, cover...
several processes from the time a woman requests an Assessment Questionnaire to the time her suitability is actually determined.

The objectives concerned come from 3 different BSC perspectives:

1. Patient Satisfaction (PS),
2. Clinical Utilisation and Outcomes (CUO) and

Specifically these include:

**PSG1:** It should take no longer than 24 hours from the time an Assessment Questionnaire is requested to the time it is dispatched.

**PSG2:** It should take no longer than 48 hours from the time of the completion of the Suitability Decision until a phone call to the woman advising her of the decision outcome is made.

**CUOG1:** 100% of suitability assessments will be conducted in accordance with the National Midwifery Guidelines for Consultation and Referral and the RMGP Model.

**CUOG2:** Completed Assessment Questionnaires, will be assessed within 1 working day of receipt.

**SICG2:** Initial Suitability decisions will have a confidence level of at least 90%.

From the case study description in Chapter 5 the measurement ‘type’, ‘unit’ and ‘target value’ can therefore be specified as:

<table>
<thead>
<tr>
<th>Objective Id</th>
<th>Measurement Type</th>
<th>Unit</th>
<th>Target Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PSG1</strong></td>
<td>Cycle time</td>
<td>Hours</td>
<td>24</td>
</tr>
<tr>
<td><strong>PSG2</strong></td>
<td>Cycle time</td>
<td>Hours</td>
<td>48</td>
</tr>
<tr>
<td><strong>CUOG1</strong></td>
<td>Compliance</td>
<td>Percentage</td>
<td>100</td>
</tr>
<tr>
<td><strong>CUOG2</strong></td>
<td>Cycle Time</td>
<td>Working day</td>
<td>1</td>
</tr>
<tr>
<td><strong>SICG1</strong></td>
<td>Confidence Level</td>
<td>Percentage</td>
<td>90</td>
</tr>
</tbody>
</table>

Table 8.1. Balanced Scorecard Measurement Details for 'Evaluate Patient Suitability'
Capture of these details necessitated extensions to the BSC XML Draft Standard (2001) and McGregor’s (2002) work as follows:

1. A ‘patientjourneymodel id’ data element has been added to provide the ability to uniquely identify the treatment stream being modeled. This enables measures for a particular treatment stream to be explicitly linked to a specific Balanced Scorecard.

2. The ‘type’ data element within the ‘measure’ construct (as added by McGregor (2002)) has been extended to provide the ability to identify additional types of measures to be recorded. This includes ‘confidence level’ and ‘compliance’.

3. The ‘unit’ data element (as added by McGregor, 2002) within the ‘measure’ construct has also been extended to accommodate for the new ‘types’ in point 2. This required the addition of a ‘percentage’ value.

4. Due to the individual working patterns associated with the Ryde Midwifery Group Practice model an additional extension was also required to the ‘unit’ data element within the ‘measure’ construct. This necessitated the addition of a ‘working day’ value.

An example of the BSC XML for the ‘Evaluate Patient Suitability’ section of the ‘RMGP Future Patient Journey Model’ is shown in Appendix B.

8.5.2 Process Definitions

Process definition output is required by both the Decision Support System and Workflow components of PJM³. The Decision Support System component requires target process measurements for each process and the Workflow component requires details of the workflow activities to be automated.

The Decision Support System component uses the process definitions and their associated target measurement to initially populate the Management Decision Support System tables within the data warehouse (see section 8.6.11). These will later be compared to the actual measurements extracted from the audit log data output from the workflow enactment engine for the purposes of variance analysis and feedback (McGregor 2002). This is further discussed in Section 8.5.3.
Processes defined as part of the future patient journey are analysed to determine if opportunities exist to automate all or parts of the workflow involved. Consideration of integration with other processes both manual and automatic is also required.

Once the decision has been made on what parts of the workflow will be automated, specification of those processes in a machine interpretable format is required. As discussed in Chapter 3, Interface 1 of the Workflow Management Coalition’s (WfMC) Workflow Reference Model (1995) supports the exchange of process definitions between external business process modeling tools and the workflow enactment service. This research will use the WfMC XML Process Definition Language (XPDL) V2.0 (2005) as the specification tool for the definition, storage and exchange of processes between the future patient journey model and the workflow automation tools.

XPDL provides a standard process design format for storing the visual diagram and process syntax of business process models and as such facilitates the development of generic process descriptions that can be read by a variety of executable languages such as the Business Process Execution Language (BPEL) (WfMC 2005; Palmer 2006). This provides the added benefit of not being forced into using a proprietary workflow engine and allows for migration to different workflow management systems in the future should a change in IT strategy occur. NB: The executable language selected to implement the process definition and the implementation and enactment of the processes is outside the scope of this work.

The XPDL for the ‘Evaluate Patient Suitability’ section of the RMGP Future Patient Journey is shown in Appendix C. The following amendments are included in this standard to facilitate the modeling constructs of PaJMa.
1. Extended attributes have been defined within the ‘activity’ construct to denote a system activity for sending the Assessment Questionnaire URL address to the patient’s nominated email address. For example:

```xml
<ExtendedAttributes>
  <ExtendedAttribute name="System Activity" value="Email"/>
  <ExtendedAttribute name="Email">
    <xyz:Email to="emailAddress" subject="Having your Baby at Ryde">
      <xyz:Attachments>
        <xyz:Attachment>%docURI</xyz:Attachment>
      </xyz:Attachments>
      <xyz:MessageText>Thankyou for your enquiry about……
      </xyz:MessageText>
    </xyz:Email>
  </ExtendedAttribute>
</ExtendedAttributes>
```

2. Within the ‘activity’ construct, extended attributes, as originally defined by McGregor (2002), have also been enhanced to provide links from the previously defined target Balanced Scorecard measurements to individual activities. For example:

```xml
<ExtendedAttribute>
  <Name>CUOGoal1</Name>
  <Value>CUOG1</Value>
</ExtendedAttribute>
<ExtendedAttribute>
  <Name>CUOCompliance</Name>
  <Value>100</Value>
</ExtendedAttribute>
<ExtendedAttribute>
  <Name>CUOComplianceType</Name>
  <Value>Percentage</Value>
</ExtendedAttribute>
<ExtendedAttribute>
  <Name>CUOGoal2</Name>
  <Value>CUOG2</Value>
</ExtendedAttribute>
<ExtendedAttribute>
  <Name>CUOCycleTime</Name>
  <Value>1</Value>
</ExtendedAttribute>
```
8.5.3 Workflow Enactment Audit Log Data

As part of workflow enactment by the workflow engine, audit logs containing details of process execution and activity are generated (WfMC 1998). Each time a process’ state (ie: initiated, running, complete, terminated) changes, a record is written to the audit log. As part of the Decision Support System (DSS) extraction process, the workflow audit logs are extracted, summarised and loaded into the data warehouse, within the DSS component of PJM³. The Management Decision Support Systems (MDSS) tables are then populated with the actual process enactment measurements for comparison against the predefined targets derived and loaded from the process definitions output from the Patient Journey Model component.

The workflow audit log data is defined using Interface 5 of the Workflow Management Coalition’s (WfMC) Workflow Reference Model (1998). To date the current version of Interface 5 does not provide an XML version of the standard as required by this research. This was however addressed by IW-MONS and McGregor’s (2002) enhancements will be applied within PJM³ to facilitate the transfer of the process enactment metrics from the workflow audit logs to the DSS component. The adaptation of IW-MONS’ XML version of Interface 5 for the ‘Evaluate Patient Suitability’ is shown in Table 8.2.
This example demonstrates the audit log record that would be generated when caseload midwife1 having the role of caseload_midwife commences work on the 'make suitability decision', activity instance SA0021, within the Evaluate_Patient_Suitability process, instance SA0054.

```xml
<?xml version="1.0" encoding="us-ascii"?>
<AuditLog xmlns:xpdl="http://www.wfmc.org/standards/docs/i5" id="Initial Patient_Suitability_Assessment_Log" Name="Initial Suitability Assessment Audit Log">
  <LogRecords>
    <LogRecord id="SA1">
      <CWADPrefix>
        <InitialProcessID>Evaluate_Patient_Suitability</InitialProcessID>
        <InitialProcessInstanceID>SA0054</InitialProcessInstanceID>
        <ActivityInstanceID>SA0021</ActivityInstanceID>
        <ProcessState>Running</ProcessState>
        <UserID>CaseloadMidwife1</UserID>
        <RoleID>Caseload_Midwife</RoleID>
        <Timestamp>07/07/2007 10:07:22</Timestamp>
      </CWADPrefix>
      <ChangeActivityInstanceState>
        <ActivityInstanceID>SA00021</ActivityInstanceID>
        <ActivityID>Make_Suitability_Decision</ActivityID>
        <NewActivityState>Running</NewActivityState>
        <PreviousActivityState>Initiated</PreviousActivityState>
      </ChangeActivityInstanceState>
    </LogRecord>
  </LogRecords>
</AuditLog>
```

Table 8.2. WfMC Interface 5 XML Version - Initial Patient Suitability Assessment (adapted from (McGregor 2002))
8.6 **Database Support**

Chapter 6 discussed a *Multi-Dimensional Patient Journey Modeling Conceptual Design* (*PJM*²) that was used in the development of the new patient journey modeling tool (*PaJMa*) presented in Chapter 7. *PJM*² is again used as the basis for the definition of the data required to be captured and loaded to the Management Decision Support System (MDSS) for use during variance analysis of *target* to *actual* measurements post patient journey enactment. *PJM*² is re-produced in Figure 8.3 to assist in the discussion concerning what data is required to support managerial analysis of implemented patient journey improvements.

![Diagram](image)

**Figure 8.3. A Multidimensional Patient Journey Modeling Conceptual Design (*PJM*²)**

Decisions on what data are needed to support the future patient journey and its definition still necessitates involvement from the stakeholders who developed the future patient journey model (FPJM). The data definition activity is undertaken within Joint Application Development (JAD) sessions similar to those used for FPJM development. Continued use of the JAD concepts helps to promote a shared understanding of how improvements will be measured thus encouraging a common sense of purpose and a commitment to goal achievement and ongoing process improvement (Phillips and Phillips 1993). With *PJM*² as the foundation for the JAD
sessions the myriad of data needed to support the FPJM can again be divided into manageable segments (individual dimensions) that can be easily understood and discussed by all stakeholders concerned.

As the majority of stakeholders are most comfortable talking about the patient journey and the processes involved, this is a logical place to begin the data definition activity. The data collected during this exercise supports the overall definition of the FPJM. At this stage the data elements are not normalised, we are only capturing the supporting data. The design of the actual database that will support managerial decision making will take any normalisation requirements into consideration later in the project (Codd 1970).

8.6.1 The Patient Journey Model

As a result of breaking the future patient journey down into individual dimensions the data elements required to be captured for the patient journey itself are at a summary level only. All of the micro-level details that comprise the overall journey are captured in the individual dimensions themselves and then queried as needed. Each table used in the following section is made up of the following columns:

**Data element name:** Common name by which the data element is known

**Description:** Plain English description of the contents of the data element

**Example value:** Provides an example of the contents of a particular data element. (NB: All example values are taken from the RMGP case study outlined in Chapter 5).

The data element sets that follow are not normalised. They are for the purposes of data description only. Therefore if more than one value exists for a given item (ie: multiple sub-processes for a given parent process) then record an individual row for each and every value.

Table 8.3 lists the minimum set of data elements to be defined for a given patient journey. The data captured is mainly concerned with summary level metrics relating to the overall patient numbers and the time the journey previously took and the new target journey time. This data is used in variance analysis conducted by management following enactment of the redesigned patient journey.
<table>
<thead>
<tr>
<th>Data element</th>
<th>Description</th>
<th>Example value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient journey name</td>
<td>Defines the name by which the Patient Journey is commonly known</td>
<td>Suitability Assessment and Booking Interview</td>
</tr>
<tr>
<td>Patient journey description</td>
<td>Describes the patient journey and its purpose</td>
<td>This PJ deals with the assessment of a woman’s suitability for the RMGP model and her subsequent booking interview(if accepted)</td>
</tr>
<tr>
<td>Estimated number of patients in journey</td>
<td>Number of patients that are expected to participate in this patient journey</td>
<td>240 per year</td>
</tr>
<tr>
<td>Estimated total patient journey time</td>
<td>Target time for a patient to complete this PJ</td>
<td>8 days elapsed time</td>
</tr>
<tr>
<td>Previous total patient journey time</td>
<td>Time for a patient to complete this PJ prior to improvement</td>
<td>3 weeks elapsed time</td>
</tr>
</tbody>
</table>

Table 8.3. Patient Journey Dimension Minimum Data Element Set and Example

Table 8.4 below lists the minimum set of data elements to be defined for each Process within a given Patient Journey. Additional elements may be defined as required by a specific HCO. The data includes details of conditions that must be met prior to and following process execution along with individual process metrics for completion and wait times and care handovers. The previous and next process/es in the stream are needed to reconstruct the overall journey sequence along with any associated sub-processes.

<table>
<thead>
<tr>
<th>Data element</th>
<th>Description</th>
<th>Example value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process name</td>
<td>Defines the name by which the Process within a PJ is commonly known</td>
<td>Allocate woman to midwife</td>
</tr>
<tr>
<td>Process description</td>
<td>Describes the process and its purpose</td>
<td>Allocates a woman to a named midwife following positive suitability assessment</td>
</tr>
<tr>
<td>Responsible department</td>
<td>Department that has been assigned responsibility for a given process</td>
<td>Maternity</td>
</tr>
<tr>
<td>Pre-condition</td>
<td>Business rule describing what conditions must be met before this process can commence</td>
<td>Woman’s details entered into RMDB</td>
</tr>
<tr>
<td>Post-condition</td>
<td>Business rule describing what conditions must have been met before execution can continue to the next process</td>
<td>Woman’s allocation details added to booking register</td>
</tr>
<tr>
<td>Estimated number of patients in process</td>
<td>Number of patients that are expected to participate in this process</td>
<td>200</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>---------------------------------------------------------------</td>
<td>-----</td>
</tr>
<tr>
<td>Previous time to complete</td>
<td>Nominates how long in minutes a given process takes to complete in the unimproved (current) PJ</td>
<td>15</td>
</tr>
<tr>
<td>Target time to complete</td>
<td>Nominates how long in minutes a given process is planned to take to complete in the improved PJ</td>
<td>5</td>
</tr>
<tr>
<td>Acceptable wait time (optional)</td>
<td>Nominates how long it is acceptable for a patient to wait</td>
<td>2</td>
</tr>
<tr>
<td>Wait time measurement scale</td>
<td>Indicates the measurement of wait time scale (ie: minutes, days etc…)</td>
<td>Days</td>
</tr>
<tr>
<td>Care handover required at completion</td>
<td>Indicates whether a care handover is required at the completion of this process</td>
<td>Yes</td>
</tr>
<tr>
<td>Previous process name</td>
<td>Name of the process that precedes this one</td>
<td>Assess suitability</td>
</tr>
<tr>
<td>Next process name</td>
<td>Name of the process that comes after this process</td>
<td>Make booking interview appointment time</td>
</tr>
<tr>
<td>Sub-process reference</td>
<td>Identifies if sub-processes exist for this process. Referenced by name.</td>
<td>Check woman's admission history, verify midwife availability</td>
</tr>
</tbody>
</table>

Table 8.4. Processes Within a Patient Journey Minimum Data Element Set and Example

It should be noted that not all of the information required to be collected may be known or available at the time a given dimension is being interrogated, viz, ‘target time to complete’ for a process within a journey. This data element may only be able to be completed once the rest of the dimensions have been interrogated and improvements agreed. Simply make a note that this data element is outstanding and return to it when the required information is available.

Each of the dimensions that impact the overall patient journey model and its processes are now discussed.

### 8.6.2 Strategic Objectives Dimension
As part of FPJM development, the Healthcare Provider’s Strategic Objectives relevant to the journey under review were documented in the form of Balanced Scorecards (BSC). The BSCs represented the specific mission, strategic directions and related objectives that will guide the organisation and how it delivers its services
to its specified clients. The BSCs are now revisited to extract relevant data that is to be used to link them to the operational measurements defined for each process.

Developers should also be cognisant that although objectives can be set at multiple levels of the organisation, viz, strategic, management and operational (Lemieux-Charles et al. 2003), certain Healthcare Organisation (HCO) mission-based objectives will be present in all patient journey models (ie: service satisfaction). All measurements relating to the BSCs will feed into the *Measurements Dimension* for analysis of planned (target) to actual figures once the redesigned patient journey is operational.

Analysis of the data required in this dimension also provides an additional opportunity to further verify the actual FPJM by ensuring compliance to industry policies as set by Government and associated accreditation bodies.

Table 8.5 lists the minimum set of data elements to be defined for each strategic objective within the BSC perspectives as they relate to a given patient journey. Additional elements may be defined as required by a specific HCO. The Measures, Targets and Initiatives are the main focus of the Strategic Objectives data element set. The ‘target value’ and ‘measurement value scale’ will be used in the *Measurement Dimension* to operationalise patient journey model metrics.

<table>
<thead>
<tr>
<th>Data element</th>
<th>Description</th>
<th>Example value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic objective name</td>
<td>Defines the name by which the strategic objective is commonly known</td>
<td><em>Patient satisfaction index</em></td>
</tr>
<tr>
<td>Strategic objective description</td>
<td>Describes the strategic objective and its purpose</td>
<td><em>Identifies the percentage of patients that are satisfied with the services offered</em></td>
</tr>
<tr>
<td>Related perspective name</td>
<td>Name of balanced scorecard perspective this strategic objective is related to</td>
<td><em>Patient satisfaction</em></td>
</tr>
<tr>
<td>Target value</td>
<td>Nominates the target value that has been set for this strategic objective</td>
<td>90</td>
</tr>
<tr>
<td>Measurement value scale</td>
<td>Describes the scale to be used for the target value (ie: dollars, days etc..)</td>
<td><em>Percentage</em></td>
</tr>
</tbody>
</table>
### Table 8.5. Strategic Objectives Dimension Minimum Data Element Set and Example

<table>
<thead>
<tr>
<th>Data element</th>
<th>Description</th>
<th>Example value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human resource name</td>
<td>Common name human resource is known by</td>
<td>Midwife</td>
</tr>
<tr>
<td>Human resource description</td>
<td>Describes the human resource and its purpose</td>
<td>Provides full range of care to women with obstetric needs</td>
</tr>
<tr>
<td>Human resource type</td>
<td>Describes the category a human resources falls into (clinical, administration, management.)</td>
<td>Clinical</td>
</tr>
<tr>
<td>Skill level of human resource</td>
<td>Describes the level of training required by the human resource type</td>
<td>Registered</td>
</tr>
</tbody>
</table>

This data element set also provides an explicit physical link between the Healthcare Provider Strategy and Patient Journey Model components of PJM as per Question 1 of the research hypothesis described in Chapter 1.

#### 8.6.3 Human Resources Dimension

For each process defined in the Process Dimension, the number and type of human resources required to fulfill that process to target is recorded in the Human Resources (HR) Dimension data element set. The HR data element set defines the actual type and skill level of the resource required, role played and section or department responsible for them for each process in the Process Dimension. Figures regarding target human resource numbers along with the cost of supplying the required human resource are also captured as part of this Dimension.

The minimum set of data elements to be defined is shown in Table 8.6 and must be defined for each type of human resource used by a process within the PJM. Additional elements may be defined as required by a specific HCO.
### Technology Support

<table>
<thead>
<tr>
<th>Role</th>
<th>Describes the role this human resource plays in this process</th>
<th>Assessing Midwife</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost per hour</td>
<td>Dollar cost per hour for the human resource</td>
<td>$30.00</td>
</tr>
<tr>
<td>Reports to department</td>
<td>Name of department human resource reports to</td>
<td>Maternity</td>
</tr>
<tr>
<td>Process name</td>
<td>Process within a PJ that the human resource participates in</td>
<td>Allocate woman to midwife</td>
</tr>
<tr>
<td>Number required for process</td>
<td>Nominates how many of the given human resource is required for this process</td>
<td>1</td>
</tr>
</tbody>
</table>

**Table 8.6. Human Resources Dimension Minimum Data Element Set and Example**

NB: A row is required for each role played by a human resource in a particular process.

#### 8.6.4 Physical Resources Dimension

The *Physical Resources Dimension* describes what and how many of each physical resource such as, space and equipment, (excluding human resources), are required to support the activities described for each process in the *Process Dimension*. The size (if applicable), number available, number required and responsible department are also defined. Financials for each physical resource must also be calculated. The calculated cost per hour must take into account the initial purchase cost and any ongoing maintenance fees for required equipment.

The minimum set of data elements to be defined is shown in Table 8.7 and must be defined for each type of physical resource used by a process within the PJM. Additional elements may be defined as required by a specific HCO.

<table>
<thead>
<tr>
<th>Data element</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical resource name</td>
<td>Name physical resource is known by</td>
<td>Ultrasound machine</td>
</tr>
<tr>
<td>Physical resource description</td>
<td>Describes physical resource and its purpose</td>
<td>Provides ultrasonic pictures of human body</td>
</tr>
<tr>
<td>Physical resource type</td>
<td>Describes type of physical resource (room, equipment etc..)</td>
<td>Equipment</td>
</tr>
<tr>
<td>Physical resource size (optional)</td>
<td>Denotes size of physical resource required (ie: 3m x 3m [room])</td>
<td>NA</td>
</tr>
<tr>
<td>Cost per hour</td>
<td>Dollar cost of using physical resource per hour</td>
<td>$25.00</td>
</tr>
<tr>
<td>Responsible department</td>
<td>Name of department responsible for physical resource</td>
<td>Maternity</td>
</tr>
</tbody>
</table>
As for the *HR* dimension, a row for each individual physical resource used by a particular process will be defined.

### 8.6.5 Patient Needs Dimension

The *Patient Needs Dimension* defines the unique socio and cultural requirements of specific patient groups that flow through a nominated patient journey. This Dimension is of particular concern in low socio-economic or indigenous areas. Other categories of patient needs can also be classified in this Dimension based on specific co-morbidity groups or carer requirements. Measurements relating to the provision of a ‘culturally safe’ care plan are fed into the *Measurement Dimensions* for variance analysis once the patient journey workflows become operational to determine the degree of compliance and/or the need for greater vigilance.

Data captured includes the type of need (ie: cultural, religious, socio-economic), any additional time or costs associated with complying with the need, what department is responsible for compliance and what process the need is associated with.

The minimum set of data elements to be defined is shown in Table 8.8 and must be defined for each patient need that impacts a process within the FPJM. Additional elements may be defined as required by a specific HCO. If more than one patient need exists for a specific process than multiple rows are defined.
<table>
<thead>
<tr>
<th><strong>Data element</strong></th>
<th><strong>Description</strong></th>
<th><strong>Example</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient Need name</td>
<td>Name patient need is known by</td>
<td>Placenta Smoking Ritual</td>
</tr>
<tr>
<td>Patient Need description</td>
<td>Describes the patient need and its purpose</td>
<td>Ritual for cleansing baby and readying it for a good life. Requires baby’s placenta to be retained for transport with woman upon discharge</td>
</tr>
<tr>
<td>Patient Need type</td>
<td>Defines the type of need (ie: cultural, socio/economic, religious etc…)</td>
<td>Cultural</td>
</tr>
<tr>
<td>Associated cost</td>
<td>Dollar cost associated with the provision of this patient need</td>
<td>$15.00</td>
</tr>
<tr>
<td>Additional time required to comply</td>
<td>Amount of extra time that is required to meet this patient need</td>
<td>20 minutes</td>
</tr>
<tr>
<td>Responsible department</td>
<td>Name of department responsible for patient need</td>
<td>Maternity</td>
</tr>
<tr>
<td>Associated Process name</td>
<td>Process within a PJ that the patient need is related to</td>
<td>Placenta disposal</td>
</tr>
</tbody>
</table>

Table 8.8. Patient Needs Dimension Minimum Data Element Set and Example

#### 8.6.6 Practice Guidelines Dimension

By explicitly linking particular practice guidelines to a process, compliance monitoring becomes a straightforward activity. Practice Guidelines that are required to comply with or attain accreditation were output as part of the Healthcare Provider Strategy analysis. Specific evidence-based best practice and clinical indicators were then identified and included as part of the FPJM.

The primary goal of the patient journey redesign activity is to remove variability in the process of care wherever possible thus increasing overall patient safety and outcomes. Practice guidelines may apply to different types of staff (nurses, doctors etc..) or for any type of healthcare worker delivering a specific type of care (ventilator support). These may form part of an overall quality improvement program such as the Evaluation and Quality Improvement Program (EQuIP) administered by The Australian Council on Healthcare Standards (ACHS 1996) or be published by a particular professional body such the National Midwifery Guidelines for Consultation and Referral by the Australian College of Midwives (2004).
At the operational level, benchmark clinical indicators are required to support measurement of the use and effectiveness of certain practice guidelines. A clinical indicator is defined as a measure of the clinical management and/or outcome of care. Indicators are best seen as measures that screen for a particular event. These are typically developed in conjunction with medical colleges, professional associations and societies. Examples include the Sentinel Event Alerts from the Joint Commission for Accreditation of Healthcare Organisations (JCAHO 2005) and the Performance and Outcomes Service Clinical Indicators from The Australian Council on Healthcare Standards (ACHS 1996).

Clinical indicators targets will be linked to the Measurement Dimension using the ‘Clinical reference indicator’ and ‘Clinical reference target’ data elements for future variance analysis.

The minimum set of data elements to be defined is shown in Table 8.9 and must be defined for each practice guideline that impacts a process within the FPJM. Additional elements may be defined as required by a specific HCO. Where more than one Practice Guideline is to be complied with for a particular process, define a row for each guideline.

<table>
<thead>
<tr>
<th>Data element</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practice guideline name</td>
<td>Name practice guideline is known by</td>
<td>National Midwifery Guidelines for Consultation and Referral</td>
</tr>
</tbody>
</table>
| Practice guideline description | Describes the practice guideline and its purpose                          | Informs decision-making by midwives on the care, consultation and referral of women:  
• at booking;  
• during pregnancy and the antenatal period;  
• during labor and birth;  
• during the postnatal period |
| Practice guideline issued by | Name of body that issues practice guideline                                  | Australian College of Midwives                                          |
| Associated Process name   | Process within a PJ that the practice guideline is related to               | Assess woman’s suitability                                              |
Clinical indicator reference | Name of clinical indicator that a particular practice guideline is linked to | Suitability assessment confidence level
---|---|---
Clinical indicator target | Target value for compliance to a given clinical indicator | 90%

**Table 8.9. Practice Guidelines Dimension Minimum Data Element Set and Example**

### 8.6.7 Administration Dimension

The *Administration Dimension* describes the type, source and movement of any paperwork (including forms) associated with the management of the patient and their journey and the manual or system administration tasks required to support the completion of these activities. Also includes definition of responsibilities and approvals required for a particular process. Specifications for system support relating to data capture, storage, retrieval and reporting are also defined as part of the *Administration Dimension*, if required. These will be linked to the *Technology Support Dimension*.

The minimum set of data elements to be defined is shown in Table 8.10 and must be defined for each Administration requirement that impacts a process within the PJM. Additional elements may be defined as required by a specific HCO. A separate record is required for each administration item involved in a process.

<table>
<thead>
<tr>
<th>Data element</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administration item identifier</td>
<td>Code used to identify administration item</td>
<td>U2AA</td>
</tr>
<tr>
<td>Administration item name</td>
<td>Name administration item is known by</td>
<td>Admission Authority</td>
</tr>
<tr>
<td>Administration item description</td>
<td>Describes the administration item and its purpose</td>
<td>Patient’s authority to be admitted to hospital and partake of hospital services</td>
</tr>
<tr>
<td>Administration item type</td>
<td>Classification of administration item</td>
<td>Form</td>
</tr>
<tr>
<td>Process name</td>
<td>Process within a PJ that the administration item is related to</td>
<td>Complete Clerical Booking</td>
</tr>
<tr>
<td>Supporting system name (optional)</td>
<td>Name of IT system that supports completion of this administration item</td>
<td>Patient Administration System</td>
</tr>
</tbody>
</table>

**Table 8.10. Administration Dimension Minimum Data Element Set and Example**
8.6.8 Technology Support Dimension
The Technology Support Dimension defines the system and technology support needed to support all of the activities associated with the redesigned patient journey as well as the analysis of the ongoing effectiveness of the journey itself.

Systems identified may be unique to a particular department or generic across the whole hospital or Area Health Service. Examples of identified technology support include electronic transfer of lab test or x-ray requests, patient admission systems or new systems to automate the redesigned workflows. There may also be a requirement to extract data from other systems or integrate closely coupled systems. Support for report production is also considered.

The minimum set of data elements to be defined is shown in Table 8.11 and must be defined for each IT System that impacts a process within the PJM. Additional elements may be defined as required by a specific HCO.

<table>
<thead>
<tr>
<th>Data element</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT system name</td>
<td>Name IT system is known by</td>
<td>Patient Administration System (PAS)</td>
</tr>
<tr>
<td>IT system description</td>
<td>Describes the IT system and its purpose</td>
<td>Captures details about Patient admission history</td>
</tr>
<tr>
<td>IT system type</td>
<td>Classification of IT system</td>
<td>Hospital wide</td>
</tr>
<tr>
<td>Responsible department</td>
<td>Department responsible for the IT system</td>
<td>IT Services</td>
</tr>
<tr>
<td>Process name</td>
<td>Process within a PI that the IT system is related to</td>
<td>Complete Clerical Booking</td>
</tr>
</tbody>
</table>

Table 8.11. Technology Support Dimension Minimum Data Element Set and Example

8.6.9 Measurements Dimension
To enable decision support and variance measurement and evaluation to pre-set standards, metrics must be set for each of the dimensions related to the patient journey. The $PJM^2$ approach first requires metrics to be set for items within each individual dimension. The definitions of these individual dimension metrics are then aggregated into the Measurements Dimension.
Technology Support

The strategic objectives outlined in the *Strategic Objectives Dimension* and benchmark targets from accreditation bodies and other acknowledged high quality similar services drive the definition of the metrics in the *Measurements Dimensions*. There are no maximum limits to the number of metrics (measurements) that can be set but there must be at least one measurement set, for each of the dimensions previously discussed.

Lemieux_Charles et al (2003) suggested that there are in fact multiple levels to be considered when developing performance measures within health care organisations (HCO).

This work built on the three levels identified by Parsons in 1960 and were described as:

- **Technical** – transforms production inputs into outputs;
- **Managerial** – administers and procures essential resources for the technical production system; and
- **Institutional** – relates the organisation to its environment and attempts to secure legitimacy.

Also impacting the development of performance indicators in HCOs are the constraints of a variety of occupational and professional standards that operational procedures and human resources must subscribe to (Scott *et al*. 2000). All of these issues see differing levels of importance placed on different performance indicators by staff at each level. *Institutional indicators* typically look at efficiency and cost containment whereas *Technical and Managerial indicators* are more concerned with items such as quality of patient care and up-to-date training.

The $PJM^2$ conceptual design caters for differing measurement levels through the use of multiple dimensions such as the *Technology Support*, *Patient Journey* and *Strategic Objectives* dimensions. In Chapter 7, *PaJMa* demonstrated how the actual patient journey model is layered, further supporting a multi-level approach to measurement definition.
Table 8.12 gives some examples of generic areas that should be considered when defining measurements for the processes within a patient journey.

<table>
<thead>
<tr>
<th>Measurement Indicator</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td># Patient Movements</td>
<td>The number of times a patient is physically moved/transferred between locations, either within the hospital or externally</td>
</tr>
<tr>
<td>Target Process Time</td>
<td>The amount of time in minutes a process in the patient journey should take to complete</td>
</tr>
<tr>
<td>Actual Process Time</td>
<td>The amount of time in minutes a process in the patient journey actually took to complete</td>
</tr>
<tr>
<td># of Adverse Events</td>
<td>The type and number of adverse events that were recorded in a given time period</td>
</tr>
<tr>
<td>Type of Adverse Event</td>
<td></td>
</tr>
<tr>
<td>Length of Stay (LOS)</td>
<td>How long the patient spent in the healthcare organisation</td>
</tr>
<tr>
<td>Laboratory Turnaround Time</td>
<td>The time from the placement of a lab test request until the test results are returned</td>
</tr>
<tr>
<td>Entity Responsible</td>
<td>The actual position, role, section or department responsible for a patient’s movement, treatment stream or information initiation and/or flow</td>
</tr>
<tr>
<td>Service Level Targets</td>
<td>Pre-defined measurements and targets for a given activity. Derived from strategic objectives</td>
</tr>
<tr>
<td>Resource Usage</td>
<td>What and how many of each associated resource including staff, space and equipment are being used by the activity</td>
</tr>
<tr>
<td>Activity Cost</td>
<td>Actual financial cost associated with the execution of a given activity</td>
</tr>
</tbody>
</table>

Table 8.12 Examples of Generic Patient Journey Metrics

The minimum set of data elements to be defined for the measurement dimension is shown in Table 8.13. Additional elements may be defined as required by a specific HCO. A separate record is required for each individual measurement that is associated with a process.

<table>
<thead>
<tr>
<th>Data element</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement name</td>
<td>Name measurement is known by</td>
<td>Process Time</td>
</tr>
<tr>
<td>Measurement description</td>
<td>Long description of measurement</td>
<td>Estimated time process will take to complete</td>
</tr>
<tr>
<td>Measurement type</td>
<td>Describes type of measurement (original, target, actual)</td>
<td>Target</td>
</tr>
<tr>
<td>Measurement value scale</td>
<td>Scale used to describe measurement value</td>
<td>Minutes</td>
</tr>
<tr>
<td>Measurement target value</td>
<td>Value expected to be achieved</td>
<td>7</td>
</tr>
</tbody>
</table>
8.6.10 Organisational Structure Dimension

The Organisational Structure Dimension supports the hierarchical reporting structure and lines of responsibility that exist within the Provider organisation. It identifies and describes the departments responsible for particular aspects of the patient journey. This includes responsibility for process performance, the human and physical resources and/or information systems involved.

If the organisational structure is already available in an automated form, this system will need to be integrated into the Future Patient Journey. If it is available in paper-based form the relevant data will need to be captured as part of this Dimension. If the organisational structure is not currently documented in any form all details will need to added as outlined in Table 8.14.

The minimum set of data elements to be defined for the organisational structure dimension is shown in Table 8.14. Additional elements may be defined as required by a specific HCO.

<table>
<thead>
<tr>
<th>Data element</th>
<th>Description</th>
<th>Example value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department name</td>
<td>The name the department is known by</td>
<td>Maternity</td>
</tr>
<tr>
<td>Manager name</td>
<td>Manager contact name</td>
<td>Melissa Abela</td>
</tr>
<tr>
<td>Reports to Department (optional)</td>
<td>Name of department this department reports to</td>
<td>Nursing</td>
</tr>
<tr>
<td>Subordinate Department (optional)</td>
<td>Name of department/s that report to this department</td>
<td>Null</td>
</tr>
</tbody>
</table>

Table 8.14. Organisational Structure Dimension Minimum Data Element Set and Example
8.6.11 Multidimensional Database Design

Multidimensional approaches as conceptualised in $PJM^2$ have been recognised as being of significance to other types of organisations such as manufacturing, insurance, banking and travel (Inmon 1996; Kimball 1996) and can be implemented using multi-dimensional database structures. Such database designs are seen most commonly in data warehouse architectures that support executive and management information systems and decision support systems (DSS) as discussed in Chapter 3. The use of DSS within the $PJM^3$ meta-methodology was discussed in Chapter 4.

As can be seen from the preceding sections, development of a patient journey model using the $PJM^2$ framework involves the collection of a considerable amount of data. How then will this data be used as part of implementing the Future Patient Journey Model? The data collected serves two critical roles:

1) Definition of the strategic objectives dimension and integration with the other dimensions provides the basis for operational alignment of the healthcare improvement outcomes to the long term strategic directions of the HCO and the benchmark for ongoing performance measurement.

2) Definition of the Patient Journey Model and other dimensions provides the operational measurement data for managerial monitoring and control of implemented improvements.

It is only through the rigorous definition of the required data that management will be able to ascertain whether implemented improvements are actually making things better or if further improvements are still necessary to reach the required targets.

Part of the physical model development includes designing the multi-dimensional database structure that will support variance analysis and management reporting for the purposes of monitoring the performance of the new patient journey. Use of a multi-dimensional approach allows the data to be sliced and diced in a variety of ways accommodating complex management querying of identified variances.

Analysis of causal relationships of acknowledged variances is provided via a ‘drill-down’ facility to the contributing dimensional data.
In the arena of healthcare improvement any implemented change to the existing patient journey must be assessed to determine if the change has made a difference and is actually enhancing the delivery of care and outcomes.

Due to the complexity and number of the items involved in healthcare improvement, navigation of the data elements required for variance analysis and reporting can be extremely complex. This is not conducive to efficient management activity and where possible database structures should be simplified to allow for increased understanding of the data and more effective analysis by the user (Kimball 1996). This suggests that a multidimensional database approach would provide the best support for a MDSS for healthcare improvement monitoring.

Figure 8.4 shows the basic design of the star schema for the purposes of a MDSS for healthcare improvement monitoring. It is based on the $PJM^2$ framework and the data collected during the development of the Future Patient Journey Model, as discussed in the previous sections.

![Figure 8.4. Star Schema for a Management Decision Support System for Healthcare Improvement Monitoring](image)

The fact table (center) is where the numerical measurements for the Patient Journey are stored. This table allows for succinct variance analysis and provides the
justification for continuance of implemented improvements or further changes. In this star schema, the fact table is called the Patient Journey Process Enactment fact table. This table represents the summarised results of the movement of a patient through each process in the Journey. These results (actuals) are then compared with the target (planned) values to determine if an improved process is under or over performing.

The dimension tables are where the textual description of the dimensions for the Journey are stored. Each textual description helps to describe a particular value in the respective dimension table (ie: each record in the patient dimension represents a specific patient that has been involved with a specific process in a patient journey.

Most of the dimension tables that are joined to the fact table are the same as those discussed in Sections 6.2.1 to 6.2.10. Those dimensional tables that are new or that have been combined into other tables require a brief explanation.

**Time Dimension:** When a process is enacted, it occurs at a certain point in time, hence the need to add a time characteristic when moving from design to implementation. The Time dimension represents a new group of attributes that facilitate the grouping of data values into various time periods. Invariably when management are analysing the Patient Journey, they will be interested in this data over a period of time such as a week, month, season etc… Definition of these time series is recorded in the time dimension and the relevant key that identifies a required time series is the joining attribute in the fact table. For example, the month of September is represented as ‘9’ in the ‘month_number_overall’ attribute in the ‘time dimension’. This means that each day in the month of September can be summarised by the database and presented as a monthly slice of data.

Thus if the analyst wishes to query the volume or type of patients in a journey for the month of September, they would only have to specify the ‘month_number_overall = 9’ and the database would understand that it was required to return a summary value representing all of the individual days values for the month of September. Storing the data using a time series allows analysts to summarise data at varying levels and to compare equivalent time series (ie: months) over time.
**Patient Dimension:** The Patient dimension represents a new group of attributes that facilitate deeper analysis of an identified variance for a particular patient. If management identifies an unexpected variance they usually want to find out more about why and under what circumstances the variance occurred. Typically they will try to ascertain if there were certain circumstances about a patient that led to the variability. By linking to the Patient dimension through the patient_key, analysts can drill down to the individual patient information. Further analysis by nationality, age or sex etc… is then possible and can assist in determining if the same variability is occurring consistently for a given group. If this is case, further enhancements must be made to the patient journey for the affected population.

Each dimensional table provides the fact table with a key to more detailed data in that dimension and through the navigation of the dimensional keys, the analyst can drill down to discover additional information about a particular variance occurrence.

**Strategic Objectives dimension:** The Strategic Objectives dimension discussed in section 6.2.2 has been normalised into the Measurement dimension table in the star schema (Codd 1970). In real terms a strategic objective target is the combination of a number of operational measurements at a higher level of summarisation. To this end, the data elements previously defined are similar to those already defined for the Measurement dimension. By adding a reference to the Strategic Objective that a given measurement relates to we can navigate this link as required.

**Organisational Structure dimension:** The data elements discussed in section 6.2.10 are actually only a reference table that serves to define the hierarchical reporting structure of the organisation. A benefit of the MDSS database is the ability to identify responsible departments and lines of reporting. This necessitated the inclusion of a responsible department attribute in the relevant dimension tables. Linking to the reference table for hierarchical reasons is achieved through the use of an additional ‘outer join’ statement as part of an SQL query. Reference table attributes are as shown in Table 8.15. NB: A row would exist for each subordinate department.
Table 8.15. Organisational Structure Reference Table

<table>
<thead>
<tr>
<th>Organisational Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>department_key</td>
</tr>
<tr>
<td>department_name</td>
</tr>
<tr>
<td>manager_name</td>
</tr>
<tr>
<td>reports_to_department_key</td>
</tr>
<tr>
<td>subordinate_department_key</td>
</tr>
</tbody>
</table>

8.6.11.1 Dimension Tables

Figure 8.5 shows the data attributes for each dimension table defined in the new multi-dimensional database design. In general the base data attributes shown in the database design are the same as those discussed in the relevant data element sections above. Where changes have been required, explanation as to what the changes are and why they have been made are included after the diagram. In all cases a system generated key to assist with query response performance has been added to each table. Other modification relate predominately to changes regarding database normalisation (Codd 1970).
Figure 8.5. Multi-dimensional Database Design for MDSS - Dimension Table Attributes
**Patient Journey Dimension Table**

The patient journey dimension table is unchanged from the data element set defined in section 6.2.1 except for the addition of a system generated key to assist with query response performance.

**Process Dimension Table**

The Process Dimension table contains the same attributes as those described in section 6.2.1 except for the addition of a `process_key` for performance reasons. Other changes include:

- Data element normalisation of the ‘target time to complete’ and ‘acceptable wait time’ value fields to the Patient Journey Process Enactment Fact Table (as `target_process_time` and `target_wait_time` respectively).
- Addition of the `name`, `description` and `scale` for the above ‘time’ attributes to the Measurement dimension table.
- Addition of ‘previous process name’ and ‘next process name’ fields to the Patient Journey Process Enactment Fact Table (as `process predecessor_key` and `process successor_key` respectively).

**Time Dimension Table**

As mentioned above the Time Dimension table is a new table that is used to identify time periods for the purposes of measurement summarisation. The data attributes within the time dimension permit the rolling up of days into weeks, weeks into months and months into quarters, seasons and fiscal years. It also aids in the identification of specific holidays and special events.

**Patient Dimension Table**

The Patient Dimension table is a new table that is required to support investigation of process variances within a patient’s journey. It facilitates categorisation of patients according to their presentation date, sex, age, socio/economic group or location and nationality.
Human Resource Dimension table
The only changes in this table relate to the addition of the ‘HR_req_key’ attribute and the data normalisation of the ‘number required for process’ attribute (as target_number_HR_req) to the Patient Journey Process Enactment fact table.

Physical Resource Dimension table
The only changes in this table relate to the addition of the ‘phys_res_req_key’ attribute and the data normalisation of the ‘number required for process’ attribute (as target_number_PhysRes_req) to the Patient Journey Process Enactment fact table.

Patient Need dimension table
The physical design of this table is unchanged from that discussed in section 6.2.5.

Practice Guideline dimension table
A new data attribute, ‘practice_GL_type’ has been added to this table. This attribute indicates whether the practice guideline is required for accreditation purposes (ie: is a clinical indicator) or has been set down as a legislative requirement, for example. Other types can be defined by the HCO. The clinical indicator data elements have been normalised to the measurement dimension table.

Administration and IT System dimension tables
No changes have been made to Administration data element set. The IT System data elements are also the same except for the addition of the ‘IT_system_key’ attribute, a system generated key to assist with query response performance.

Measurement dimension table
The Measurement Dimension table stores the descriptive attributes for each measurement associated with a process. The value for the measurement as it relates to a specific patient in a process is stored in the patient journey process enactment fact table. It should be noted that each and every performance measure must be:

1. Linked explicitly to at least one strategic objective and
2. Be described and captured only once at the source of the actual activity performance
The majority of attributes are the same as those described in section 6.2.9 except for the addition of the ‘measurement_key’, ‘strategic_obj_perspective’ and ‘practice_GL_reference’ attributes.

The ‘strategic_obj_perspective’ attribute when combined with the ‘strategic_objective_reference’ attribute facilitates the linking of a measurement to a specific strategic objective and balanced scorecard perspective. The importance of linking each and every measurement to a strategic objective has been discussed previously and provides a solution to hypothesis 1.

The ‘practice_GL_reference’ attribute supports the linking of measurements associated with a specific practice guideline (ie: a clinical indicator). This attribute is a foreign key to the ‘practice_GL_key’ in the Practice Guideline dimension table.

8.6.11.2 Fact Table

Patient Journey Process Enactment fact table

The Patient Journey Process Enactment Fact Table represents the summarised results of the flow of a patient through each process in the journey. The fact table is made up of the key from each and every related dimension table as well as additional summarised information. Once a patient has passed through a particular journey, actual details of their journey are transmitted to the data warehouse for variance analysis and decision support. The actual results are then compared with the target (planned) values to determine if an improved process is performing as expected or if further patient journey enhancements are required.

The fact table is made up of a number of keys and associated summary data. The data attributes contained in the Patient Journey Process Enactment Fact Table are shown in Figure 8.6.
Figure 8.6. Patient Journey Process Enactment Fact Table Attributes

Explanation of the data keys in this table is as follows:

A particular patient journey is made up of

One or more processes

The journey occurs at a specific point in time for

A given patient who required

A certain number and type of human and physical resources and

Had specific patient needs

The patient journey process also involved specific practice guidelines and administration requirements which were

Supported by particular IT systems

All of which have related measurements.
Technology Support

To enable the process sequence flow for a particular patient journey to be constructed, a 'process_predecessor_key' and 'process_successor_key' have been included. These are taken directly from the Process dimension table.

It must be noted that there will be a unique row in the fact table for every combination of the dimension table keys. The additional summarised information for a given combination of the above keys includes:

<table>
<thead>
<tr>
<th>Data Attribute</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>process_pre_condition</td>
<td>Specific rules that must be met before the process in this patient journey can commence</td>
</tr>
<tr>
<td>process_post_condition</td>
<td>Specific rules that must be met before the process in this patient journey can be finalised</td>
</tr>
<tr>
<td>target_process_time</td>
<td>Preset target that a process should be completed in</td>
</tr>
<tr>
<td>actual_process_time</td>
<td>Actual amount of time the process took to complete</td>
</tr>
<tr>
<td>target_number_HR_req</td>
<td>Number of human resources the process was supposed to use</td>
</tr>
<tr>
<td>actual_number_HR_req</td>
<td>Number of human resources the process actually used</td>
</tr>
<tr>
<td>actual_HR_cost</td>
<td>Total actual cost of human resources used in this process</td>
</tr>
<tr>
<td>target_number_phys_res_req</td>
<td>Number of human resources the process was supposed to use</td>
</tr>
<tr>
<td>actual_number_phys_res_req</td>
<td>Number of physical resources the process actually used</td>
</tr>
<tr>
<td>actual_phys_res_cost</td>
<td>Total actual cost of physical resources used in this process</td>
</tr>
<tr>
<td>target_wait_time</td>
<td>Preset target for acceptable patient wait time</td>
</tr>
<tr>
<td>actual_wait_time</td>
<td>Actual amount of time a patient waited</td>
</tr>
<tr>
<td>Target_measurement_value</td>
<td>Target value of a given process measurement (non-human or physical)</td>
</tr>
<tr>
<td>actual_measurement_value</td>
<td>Actual value of a given process measurement (non-human or physical)</td>
</tr>
<tr>
<td>practice_GL_followed</td>
<td>‘Y/N’ flag indicating if the required practice guideline was followed for this process</td>
</tr>
<tr>
<td>patient_need_met</td>
<td>‘Y/N’ flag indicating if the required patient need was met for this process</td>
</tr>
<tr>
<td>administration_reqs_completed</td>
<td>‘Y/N’ flag indicating if the required administration procedure was completed for this process</td>
</tr>
</tbody>
</table>
One of the attractions of using a multidimensional database approach is that it can be implemented using a standard relational database product such as SQL Server. This eliminates the need to purchase specialised software to store and manage the data warehouse that supports the decision support system.

8.6.11.3 SQL Query and Report Example

Once the above data has been loaded into the data warehouse, a wide variety of analysis is available. All analysis is conducted using standard Structured Query Language (SQL). The following SQL example produces a report detailing which processes within a patient journey are exceeding their ‘target_process_time’ by more than 10 minutes for the month of January.

```
select j.PJ_name, p.process_name, f.target_process_time, f.actual_process_time, (actual_process_time – target_process_time)
from patient_journey j, process p, patient_journey_process_enactment_fact f, time t
where f.PJ_key = j.PJ_key
    and f.process_key = p.process_key
    and f.time_key = t.time_key
    and t.month = ‘january’
    and f.actual_process_time – f.target_process_time > 10

Figure 8.7. Example SQL query
```
The resulting report would be similar to the following:

**Processes That Exceeded Their Target Completion Time by More Than 10 minutes**
**For the Month of January**

<table>
<thead>
<tr>
<th>PATIENT JOURNEY NAME</th>
<th>PROCESS NAME</th>
<th>TARGET PROCESS TIME (MINS)</th>
<th>ACTUAL PROCESS TIME (MINS)</th>
<th>EXCEEDED BY (MINS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital admission from ICU</td>
<td>Transfer patient to ward</td>
<td>15</td>
<td>35</td>
<td>20</td>
</tr>
<tr>
<td>Patient X-ray</td>
<td>Transfer patient to x-ray</td>
<td>12</td>
<td>47</td>
<td>35</td>
</tr>
<tr>
<td>Patient X-ray</td>
<td>Transfer patient to ward after x-ray</td>
<td>12</td>
<td>27</td>
<td>15</td>
</tr>
</tbody>
</table>

Analysis of this report seems to indicate that there are some consistent issues surrounding the transfer of patients within the hospital. This would lead to further investigations in this specific area. Additional queries could also be written to discover which particular patients were involved in these delays and if they shared anything in common. This drill-down may highlight common problems for specific patient groups.

### 8.7 Conclusion

This chapter discussed the technology required to support the development and implementation of $PJM^3$ as it relates to the Future Patient Journey Model (FPJM) constructed as part of a Healthcare Improvement project.

Key focus was directed towards supporting the transfer and integration of the data required to support the Healthcare Provider Strategy, process definitions, workflow automation and the Management Decision Support System database. Examples of the XML based definitions of the Balanced Scorecard objectives and PJM process definitions were specified using the BSC XML Draft Standard (Balanced Scorecard Collaborative 2001) and the WfMC XML Process Definition Language (WfMC
Technology Support

2005) respectively. To facilitate the requirements of the Healthcare domain and PJM\(^3\) in particular, a number of enhancements to the XML standards were made. The XML examples are included in Appendix B and C. These specifications provide explicit linking of the core components of PJM\(^3\), namely the Healthcare Provider Strategy to the Patient Journey Model and from the Patient Journey Model to the Workflow and Decision Support System components as per research hypothesis 1.

The conceptual design of PJM\(^3\), provides a foundation for the specification of the data needed to describe the multiple dimensions associated with a patient’s movement through the Healthcare Organisation and the inter-relationship and interactivity of these contributing dimensions.

This approach resulted in the development of a minimum set of data elements for each dimension. The contents of the suggested data elements would be built up as the patient journey model development progressed, leading to the collection of a broad and significant dataset of patient journey information.

The information collected during the patient journey modeling activity was then translated into a physical database design. This multidimensional database design forms the basis for a Management Decision Support System (MDSS). The MDSS provides the information required for ongoing monitoring and control of implemented healthcare improvements and the identification and analysis of process variance.

The examples of the technology described in this Chapter support research hypothesis 4 as in Chapter 1; specifically that components of the framework can be explicitly linked and enabled by readily available technology.
CHAPTER 9
THESIS CONCLUSION AND FUTURE WORK

9.1 Summary and Research Hypotheses Solutions

This thesis addressed a significant issue within the healthcare domain - the lack of a patient journey modeling framework, designed specifically for healthcare.

The research dealt primarily with modeling the manner in which healthcare is delivered, that is ‘the system of care’. The underlying premise is that each aspect of clinical care is made up of multiple processes and combining these processes creates the ‘system of care’ for that particular task. Therefore unless you change and improve the system there will not be an improvement in results, that is, outcomes. In this research, analysis and redesign of the ‘system of care’ is represented via a graphical process model or in healthcare terms a ‘Patient Journey Model’.

Patient Journey Modeling is a patient-centric activity that details a patient’s progress through a healthcare system for a given service (NHS Modernisation Agency 2005; NHS Modernisation Agency 2005). The goal of Patient Journey Modeling (PJM) is to improve patient safety and overall health care quality by reducing variability in the care process. It involves the analysis of the overall processes involved with the movement of a patient through a healthcare system, typically a hospital, and then analysing how this journey can be improved via:

- the removal of unproductive and excessive activities,
- the removal of process duplication,
- the introduction of evidence-based best practice,
- collecting required information only once,
Thesis Conclusion and Future Work

- reducing the number of times a patient is moved,
- the application of integrated information technology and
- improved communications between the patient, their carers and the clinicians involved with the journey itself.


To support the IOM’s ‘Aims for Improvement’ and to overcome the existing patient journey modeling deficiencies, the thesis suggested three key research directions:

1. **Alignment of organisational change to the Healthcare Provider Strategy**;
   Research regarding the criticality of aligning organisational change with the business strategy has been occurring for almost 30 years (Miles *et al.* 1978; Henderson and Venkatraman 1991). This indicates that the Provider Strategy sets the course for organisational change and that all improvements must be aligned to the established strategic objectives.

2. **Incorporation of Practice Guidelines and Patient Needs in the Redesigning Care Activity**.
   At the operational level, practice guidelines and patient needs are a critical input to the redesign process. Inclusion of these items keeps the models patient-centered and ensures a focus on patient safety.

3. **Provision of Appropriate System Support using Readily Available Technology**.
   Technology is a key enabler of organisational change and system support for workflow automation and performance measurement and evaluation is a standard requirement.
This in turn led to the development of the research hypotheses, which postulated that:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.</strong></td>
<td><strong>A generic framework can be defined to outline the key components required to support safe, high quality patient journey improvements, including strategy and process definition, workflow support and performance measurement and evaluation criteria.</strong></td>
</tr>
<tr>
<td><strong>2.</strong></td>
<td><strong>Such a framework can accommodate the nuances and complexities associated with healthcare redesign in particular the inclusion of patient needs and practice guidelines.</strong></td>
</tr>
<tr>
<td><strong>3.</strong></td>
<td><strong>The framework can be used to evaluate existing process modeling techniques employed in healthcare and/or to develop new healthcare specific process modeling techniques.</strong></td>
</tr>
<tr>
<td><strong>4.</strong></td>
<td><strong>Components of the framework can be explicitly linked and enabled by readily available technology.</strong></td>
</tr>
</tbody>
</table>

### 9.2 Major Contributions

The original contributions of this thesis enhance the field of healthcare improvement by providing new theoretical constructs for the conduct of patient journey modeling projects. More importantly the major contributions of this research also provide practical tools that can be used by healthcare staff with little or no previous process improvement experience to improve the consistency and quality of outcomes for patient journey redesign initiatives.

The applicability and operational benefits of the research outcomes were instantiated through the use of a primary-care maternity case study at a suburban public hospital in New South Wales, Australia.
To address the research hypotheses, this thesis demonstrated the following contributions:

- **PJM³ - A PATIENT JOURNEY MODELING META-METHODOLOGY.**

  *PJM³*: as described in Chapter 4, is an original domain specific improvement architecture that is expressly designed to support patient journeys in the context of process redesign within the healthcare domain for the purposes of increased patient safety, reduced variations of care and overall outcome improvement.

  The *Meta-Methodology* allows for the definition of the healthcare provider strategy, in the form of *Balanced Scorecards*, and for these to be explicitly linked with operational process changes. *PJM³* also accommodates the inclusion of relevant legislation/policies and accreditation requirements, practice guidelines and patient needs into the process modeling activities. Resulting process specifications can be output to workflow management systems for automated workflow support. Performance measurement criteria can be defined for inclusion in Decision Support Systems thus providing facilities to evaluate process change and feedback results to management for ongoing process improvement.

  Development of *PJM³* involved aspects of method reconciliation and consolidation as well as the addition of specific dimensions unique to healthcare such as patient needs and practice guidelines.

  The *Meta-Methodology* construct acts as a backbone for the solution of the research hypotheses, specifically hypotheses 1 and 2 and is instantiated through the development of the following suite of complimentary patient journey modeling constructs.
• **A PROCESS MODELING ASSESSMENT FRAMEWORK FOR HEALTHCARE (PMAF4HC).**

The Assessment Framework is derived from *PJM*³ and serves two key purposes:

1. To evaluate the degree of support afforded to healthcare process redesign projects by existing process modeling techniques/methods,
2. To provide a benchmark for the development for new patient journey modeling tools.

Such a Framework allows healthcare improvement managers to understand the limitations of the tools they are using so that contingencies can be developed or new tools sourced.

The Assessment Framework was demonstrated via the evaluation of the four predominant process modeling techniques currently being used for healthcare improvement: Lean Thinking, Six Sigma, ARIS and Unified Modeling Language.

The evaluation led to the identification of a range of deficiencies relating to the level of support provided by these tools. Specifically the evaluation revealed that only ARIS partially covered some of the more critical areas such as the capture of organisational goals and the socio/economic and cultural needs of patients, although this is in the form of a generic ‘environmental data’ object only. Although the ARIS method covered more of the given assessment areas than other methods it was the least intuitive to use and this is seen as a major disadvantage for healthcare workers involved in process improvement initiatives. None of the methods are patient centric or identify discontinuities of care or patient handovers. The ability to define the role type and skill level required, to deliver a particular clinical treatment and who is responsible for a given physical resource is also lacking.

Development of the *Process Modeling Assessment Framework for Healthcare* provides a solution to research hypothesis 3.
• **PJM²: A MULTI-DIMENSIONAL PATIENT JOURNEY MODELING CONCEPTUAL DESIGN.**

This artifact is derived directly from **PJM²** and presents a high level abstraction of the multiple contributing dimensions that must be considered when analysing a patient journey. Apart from the actual journey of the patient, nine (9) dimensions have been recognised as contributing to an accurate picture of the movement of a patient through the HCO.

- Strategic Objectives Dimension
- Human Resources Dimension
- Physical Resources Dimension
- Patient Needs Dimension
- Practice Guidelines Dimension
- Administration Dimension
- Technology Support Dimension
- Measurements Dimension
- Organisational Structure Dimension

Specifically these Dimensions provide a portal through which to view the complex environment of patient journey model development and supporting database designs.

This construct provides additional support for the resolution of research hypotheses 1, 2 and 3.

• **PaJMa – A PATIENT-CENTRIC PATIENT JOURNEY MODELING TOOL.**

*PaJMa* is a new graphically-based patient journey modeling tool that has been purpose built for the healthcare domain to support the design of safe, high quality patient journeys. This innovative patient journey modeling tool, explicitly accommodates a number of new dimensions not previously catered for, specifically the inclusion of practice guidelines and patient needs. Patient needs and practice guidelines are included in
Thesis Conclusion and Future Work

*PaJMa* through the use of a multi-layered process modeling approach. Development of the patient journey model is carried out via definition of six (6) contributing layers, namely:

- Patient Movement
- Staff Roles
- Processes
- Information Creation/Update
- Patient Needs/Practice Guidelines/Policies
- Measurements

Colour-coding is used to differentiate the contributing layers, allowing stakeholders to readily identify the myriad of different components associated with redesigning a holistic patient journey.

The tool also introduces innovative techniques for visualising patient flow problems from a multi-dimensional perspective, allowing the patient journey to be ‘sliced and diced’, that is developed and viewed from a variety of perspectives, thus providing for diverse stakeholder input and discussion.

Benefits of the new tool were also confirmed via its evaluation using the *Process Modeling Assessment Framework for Healthcare* as discussed above. It was shown that *PaJMa* covered specific areas not previously catered for including Healthcare Provider Strategy links to operational processes and metrics, explicit definition of Patient Needs, linking of Practice Guidelines to individual workflow activities and explicit modelling of care handovers and discontinuities of care. More importantly all of this is dealt with on the one model with no need to include ‘add-on’ tools. This suggests that PaJMa presents significant opportunities to the current healthcare improvement environment and should be considered as a serious replacement for the incumbent tools.

The development of the *PaJMa* tool provides a solution to research hypotheses 2 and 3.
IMPROVED TECHNOLOGY SUPPORT FOR PATIENT JOURNEY MODELING.

Technology is a key enabler of healthcare improvement. This research provided specifications for explicit linking of the key components of the Meta-Methodology using XML (and its variant standards), a readily available data transfer and integration language.

Specifically the healthcare provider strategy can be defined using Balanced Scorecards with each Scorecard perspective being specified using the Balanced Scorecard XML standard (Balanced Scorecard Collaborative 2001). Implementation of PJM necessitated extensions to the BSC XML Draft Standard (2001) and McGregor’s (2002) work as follows:

1. A 'patientjourneymodel id' data element was added to provide the ability to uniquely identify the treatment stream being modeled. This enables measures for a particular treatment stream to be explicitly linked to a specific Balanced Scorecard.

2. The 'type' data element within the 'measure' construct (as added by McGregor (2002)) has been extended to provide the ability to identify additional types of measures to be recorded. This includes 'confidence level' and 'compliance'.

3. The 'unit' data element (as added by McGregor, 2002) within the 'measure' construct has also been extended to accommodate for the new 'types' in point 2. This required the addition of a 'percentage' value.

4. Due to the individual working patterns associated with the Ryde Midwifery Group Practice model an additional extension was also made to the 'unit' data element within the 'measure' construct. This necessitated the addition of a 'working day' value.

Detailed examples of these extensions are included in Appendix B.
XML in the form of the Workflow Management Coalition’s (WfMC) XML process definition language (XPDL) (WfMC 2005) was also used to specify workflow requirements as identified during new patient journey analysis activities. This facilitates the automation of required workflows in any XML compatible workflow management system.

To facilitate the modeling constructs of PaJMa the following amendments to the XPDL standard were required:

1. Extended attributes have been defined within the 'activity' construct to denote a system activity for sending the Assessment Questionnaire URL address to the patient’s nominated email address.

2. Within the 'activity' construct, extended attributes, as originally defined by McGregor (2002), have also been enhanced to provide links from the previously defined target Balanced Scorecard measurements to individual activities.

Detailed examples of these extensions are included in Appendix C.

Technology support for the evaluation of implemented patient journey improvements was also enabled via the development of a Multi-dimensional database design. The original database design consists of a central fact table providing summary details of each and every patient that is involved in a given patient journey. Additional details for each part of the journey are captured in the associated dimension tables. Drill down to individual Processes enacted at a specific point in Time using Human and Physical Resources, for a particular Patient with individual Patient Needs is facilitated. Along with details on the Administration and IT Support required and the entire spectrum of Measurements that aid management decision making.

Using $PJM^1$ and $PJM^2$ as the design foundation; this database facilitates the capture of performance measurement and evaluation criteria. Such criteria can be implemented as part of a Management Decision Support System (MDSS) to assist organisational learning and to assess the degree
of improvement that can be attributed to process changes made as a result of new patient journey model implementations.

MDSS outputs can also be used by management as justification for ongoing process improvements and provide a feedback loop to the healthcare provider strategy.

The XML extensions and new multi-dimensional database design discussed above provide solutions to research hypothesis 4.

All of these constructs are expressly designed for the healthcare domain for the purposes of improved support for the design and modeling of patient journeys.

### 9.3 Research Impacts

The innovative techniques described help stakeholders to visualise how a patient moves through the entire system (not just one department), bringing together the multiple dimensions required to improve the patient journey at a holistic level and highlighting areas of patient risk, resource wastage and process duplication at their source. In addition the new techniques provide a common communication base for all involved parties thus encouraging interaction from all levels and types of stakeholders including patients and clinicians, promoting action plan ownership and supporting the definition of specifications for integrated information systems. The research also provides for the definition of the performance monitoring and evaluation criteria required for the development of decision support systems that will provide feedback to management, promoting a continuous process improvement culture.

The combination of these items within $PJM^3$ enables links between these contributing areas to be established and the impact of their relationship and interaction to be monitored, evaluated and (if needed) further improved. The conceptual design ($PJM^2$) that forms part of the Meta-Methodology’s Patient Journey Modeling component provides explicit dimensions that must be analysed and evaluated for
their impact on the current and future patient journey. This provides succinct direction to the model creators and concrete justification of recommended changes to the current patient journey, for management.

The Assessment Framework also presents a standard skeleton that can be used to evaluate any process modeling technique/method that is being considered for use within a healthcare improvement project encompassing patient journey modeling as per the \( PJM^3 \) components. Identification of low levels or complete lack of support in particular areas alerts Management to areas of weakness and the fact that other tools/techniques may be required to augment the patient journey modeling activity to improve the chances of high quality results. The Assessment Framework can also be used as a benchmark for the development of new patient journey modeling tools such as \( PaJMa \), as presented in Chapter 7.

The new and innovative constructs produced as part of this research were demonstrated in the evaluation of the primary care maternity services model at Ryde Hospital, Australia. The issues highlighted as part of the patient journey model have been addressed and progressive implementation of the future patient journey model is ongoing. Several immediate improvements were made as a direct result of the patient journey modeling project including streamlining of the Suitability Assessment process through the creation of a Suitability Assessment Questionnaire as discussed in Chapter 7. This artefact was developed by the midwives and is already available in paper copy for inclusion as part of the Information Pack provided to prospective patients. A Suitability Assessment Questionnaire website has also been developed and is currently being assessed for implementation into the Area Health Service architecture. Use of the \( PaJMa \) tool, as part of the case study confirmed that the tool encourages group communication, is quickly developed and easy to understand, promotes ownership of problems and their solutions and allows for simple identification of required action plans.

Also of significance are the impacts in relation to the \( IOM's \ Six \ 'Aims for Improvement' \) (Committee on Quality of Health Care in America 2001) as discussed in Chapters 1 and 2. By providing \( Practice Guidelines \) and \( Patient Needs \) as inputs
to the *Healthcare Provider Strategy*, Points 2, 3 and 6 of the *IOM’s ‘Aims for Improvement’* are addressed. Additional abstractions described in these components are also included in the analysis of the *current patient journey* and the design of the *future patient journey*. This supports the IOM’s Points 1 through 6. Technology support for *workflow* and *decision support* also facilitates a Continuous Improvement Loop. This ensures ongoing attention to each of the ‘Aims for Improvement’ providing a solid foundation for the delivery of safe, high quality patient journeys.

### 9.4 Limitations of PJM³

As discussed throughout this thesis PJM³ relies on a number of different components to fully describe the patient journey. If the selected patient journey modeling tool cannot accommodate all of these components then the maximum benefits of the *Meta-Methodology* will not be realised. Examples of this can be seen in Chapter 5 which described a number of tools that lack support for several of the PJM³ components such as *Practice Guidelines* and *Patient Needs*.

Currently PJM³ and PaJMa are predominantly theoretical constructs with limited software support. Microsoft Visio© is used for the development of the graphical Patient Journey Models but there are currently no automated facilities within this tool for the creation and/or capture of the Healthcare Provider Strategy perspectives and related objectives in *Balanced Scorecard XML* (*BSC XML*) (Balanced Scorecard Collaborative 2001) and the linking of these to the Patient Journey Model, as described in Chapter 8 and Appendix B. This is also the case for the creation of the *XML Process Definition Language* (*XPDL*) (WfMC 2005) specifications for transfer of the process definitions from the Patient Journey Model component to the *Workflow* and *Decision Support System* components. Automated support for the capture of the workflow management system audit logs (*WfMC Reference Model - Interface 5*) (WfMC 1995) for the purposes of transferring the actual patient journey metrics to the Decision Support System for variance analysis is also not available within Microsoft Visio©. The full potential of the PJM³ approach will not be realised without further attention to this area of software support (see Future Work section).
9.5 Future Work

The contributions of this thesis set the scene for additional research work to further the domain of healthcare improvement in the following areas.

- In Chapter 7, the PaJMa patient journey models were developed using Microsoft Visio®. As discussed above ‘Visio®’ can recreate the graphical model representations but lacks complex support for the definition of each of the objects placed on the model and explicit linking of the PJM³ components. For example the data supporting the definition of a specific patient need (ie: the need category, religion, cultural etc,…) cannot be captured. Development of such software support would also involve facilities for the automatic generation of Balanced Scorecard XML to explicitly link the Healthcare Provider Strategy and Patient Journey Model components of PJM³. Additional facilities are also required for the automated definition of patient journey model process definitions from the Patient Journey Model component to the Decision Support System and Workflow Management components. This would be in the form of XPDL as per the WfMC Interface 1 and discussed in Chapter 8.

The PaJMa software tool would also need additional functionality to support other components of PJM³ such as practice guidelines, simulation modeling and statistical analysis tools as outlined in the following points.

a) Further research is needed into how existing clinical guideline software can be integrated into the PaJMa tool to facilitate the automated inclusion of practice guidelines into the Patient Journey Model component of PJM³. It is anticipated that these tools could be integrated into the proposed environment with minimal new development and that XML should be investigated as the primary integration medium. XML could be further leveraged within this environment for the development of XML schemas or ontologies for the standard definition of practice guidelines that can be explicitly linked to the Patient Journey Model. This would facilitate the seamless integration of new or amended practice guidelines without the need for additional software development.
b) The PaJMa tool should also include linkages to existing Simulation Modeling tools such as Simul8 (Klein et al. 1993; Harper and Gamlin 2003; Brailsford 2005). This would allow solution alternatives, as suggested by various stakeholders, to be assessed as they arise. The selected alternative should then provide direct input to the development of the resulting process definitions. If following implementation of the future patient journey, performance monitoring and evaluation by the MDSS highlights that further journey enhancements are still needed to achieve the pre-defined targets, then additional simulation modeling could be performed using the same tool.

c) The PaJMa software tool would also benefit from linkages to Statistical Analysis Tools for the purposes of Patient Flow analysis as discussed by Litvak et al. (2005) and Jensen et al. (2006). Details of how patient flow analysis relates to patient journey modeling were presented in Chapter 7.

- At present the design of the Management Decision Support System database discussed in Chapter 8 has been completed. Actual construction, implementation and ‘live’ data runs are still required. Notwithstanding development of the $PJM^3$ architecture, construction of the actual multidimensional database system within a data warehouse environment along with the accompanying extraction and summary programs and graphical user interface would be of significant benefit to Patient Journey Modeling initiatives in its own right. This initiative would also require integration with existing operational systems so that individual data relating to a patient’s journey could be collected as required. Such as system would allow management to assess improvements in relation to expected targets and to learn from identified variances. Variances also highlight opportunities to make additional patient journey enhancements, encouraging a culture of continuous process improvement as outlined in Chapter 4.
• Investigation of the applicability of adding intelligent agents to the \( PJM^3 \) architecture is also an open research question deserving attention. Such investigations could look to incorporate automation of the MDSS table generation and extraction of the workflow audit logs as per McGregor’s IW-MONS for business process modeling (McGregor 2002).

• Notwithstanding the application of the new research tools within the Maternity (both metropolitan and remote) and renal failure arenas, further research is required to test the tools in additional and potentially more complex healthcare environs. As much attention has already been given to Emergency presentations and in-hospital patient journeys, by other researchers and consultants, these may be an ideal starting point. This would allow direct comparisons to be made between existing techniques and PaJMa and demonstrate the richness of the PJM3 approach. Issues of particular note may include integration of practice and professional guidelines for medication orders and administration, shiftwork handovers and accommodation of inter-organisational and cross-discipline politics.

• As part of the physical implementation of the Management Decision Support system database discussed in Chapter 8 and to better facilitate information sharing amongst users, consideration also needs to be given to compliance to an ontology (existing or newly developed) inclusive of standard naming conventions and data types. Analysis of topical research in these areas should include a review of current work by the National Health Data Management Committee (Australian Institute of Health and Welfare 2003) and the Australian Institute of Health and Welfare’s meta data online registry, METeOR. METeOR provides national data standards for health, housing and community services in Australia (Australian Institute of Health and Welfare 2003). Such a review should consider what data should be collected, who’s responsibility this would be and at what time intervals the data is collected. Consideration should also be given to whether enhancements to the minimum national dataset are also required.
• Finally the fact still remains that there is no standard patient journey modeling technique accepted and used by the healthcare industry as a whole. Further testing of \( PJM^3 \) and the accompanying thesis constructs in other healthcare improvement environs is therefore required. The constructs presented as part of this research are applicable in all parts of the healthcare domain for any type of patient journey. If further testing of the model showed consistently good results, consideration of the \( PaJMa \) technique as an industry standard could be proposed. This would provide several benefits including common understanding of patient journeys across providers, identification of best practice patient journeys for particular treatments, and new opportunities for model reuse across similar providers.

In addition to the thesis case study herein, additional testing of the presented constructs has already been conducted by this researcher, and results to date have been very encouraging. In the very early stages of the development of \( PJM^3 \) and \( PaJMa \) these tools were utilised as part of a scoping workshop in collaboration with Charles Darwin University in the Northern Territory of Australia. The scoping workshop dealt with how the journey of indigenous women living in remote communities differed from those women living in more metropolitan communities. The results of the scoping workshop led to the development of a National Health and Medical Research Council (NHMRC) grant application in partnership with Charles Darwin University, the Northern Territory Department of Health and two indigenous communities in the far North of Australia. I was named a Chief Investigator on this application. In May 2007 the team was notified that the NHMRC grant application had been successful and funds from this project will total over AUD$500,000-. I will lead the patient journey modeling component of the project which will utilise the now finalised \( PJM^3 \) and the \( PaJMa \) patient journey modeling tool.

Discussion have also commenced with the Menzies Research Centre in the Northern Territory of Australia to work with them on the development of the
patient journey models relating to indigenous patients in stages 4 and 5 of renal failure. This project is expected to commence in November 2007.

9.6 Final Conclusion

In summary the new patient journey modeling meta-methodology (\(PJ{M}^3\)) presents an innovative multidimensional healthcare improvement architecture that allows for the inclusion of the healthcare provider strategy in the form of Balanced Scorecards, along with the ability to accommodate relevant legislation/accreditation requirements, practice guidelines and patient needs. The meta-methodology formed the foundation for the development of a new Assessment Framework that can be used to evaluate existing process modeling tools or to develop new patient journey modeling tools. \(PJ{M}^3\) was also used as the benchmark for the abstraction of a patient journey model conceptual design. This conceptual design, known as \(PJ{M}^2\), provides a straightforward technique for dividing the complexities of patient journey models into manageable segments that can be developed and integrated over time. These contributions led to the development of a new healthcare specific patient journey modeling tool, known as PaJMa. The PaJMa tool provides an innovative approach to the graphical representation of the system of care. It is the first patient journey modeling tool designed specifically for the healthcare domain. PaJMa is supported by an original database design that facilitates performance measurement of implemented changes in the form of a Management Decision Support System. Outputs from the patient journey modeling tool also provide process definitions that can be used as direct input to workflow automation activities that are explicitly linked and enabled by readily available technology.

In addition the new techniques provide a common foundation for everyone involved in the patient journey modeling project thus encouraging interaction from all levels and types of stakeholders including patients and clinicians. This promotes cross-discipline communication, strong stakeholder buy-in, ownership of problems and their solutions and allows for simple identification of required action plans.
Footnote: How ironic that I am writing the conclusion to this thesis from my hospital bed! I have been a victim of one of the very types of issues my research work is trying to overcome – poor patient safety.

I had been admitted to a local hospital for day surgery for a minor gynecological complaint. I left hospital feeling tired but quite well. Three days later I was readmitted to Emergency with a bowel infection known as clostridium, contracted whilst in hospital for the day surgery. It was thought that I may need further surgery but this thank goodness was ruled out. I have however been in serious pain and hooked up to an antibiotic drip for 5 days with the Doctors thinking I will be here for another couple of days yet.

A prime example of poor patient safety leading to a medical injury unrelated to the patient’s original medical complaint!
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Sahler, O. J. and Carr, J. E., (2003), Behavioral Sciences and Health Care, Hogrefe & Huber, Cambridge, MA.


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Appendix A
PMAF4HC – Detailed Questions by Category
APPENDIX A -
PMAF4HC– DETAILED QUESTIONS BY CATEGORY

Healthcare Provider Strategy (HPS)
1. Can the health care provider strategy be explicitly captured?
2. Can measurements relating to the strategic objectives be defined?
3. Can strategic objective measurements be incorporated into the process model explicitly or implicitly? (Green and Rosemann 2000)

Patient Journey Model (PJM)
1. Does the Patient Journey (PJ) modelling technique provide specific support for the healthcare domain?
2. Is the language and notation used to express healthcare concepts meaningful? (Green and Rosemann 2000)
3. Is the model development activity intuitive to healthcare stakeholders? (Green and Rosemann 2000)
4. Can relationships to other dimensions be explicitly defined?
5. Does the method/technique allow for multiple process levels?
6. Are dataflows included?
7. Are conditional paths explicit/implicit/not permitted?
8. Is process fallout implicit/explicit?
9. How is the flow of control represented?
10. Does the PJ model have the ability to record expected completion times?
11. Can other process metrics be defined on the PJ model?
12. Can discontinuities of care/care handovers be identified?
Appendix A - PMAF4HC – Detailed Questions by Category

**Human Resources (HR)**
1. Can roles be defined for internal and external actors?
2. Can the role be explicitly linked to an associated process?
3. Can the skill type and level required to complete the process be specified?
4. Can organisational structure be explicitly defined?
5. Can roles be shown on the PJ model?
6. Can roles be differentiated on the PJ model?

**Physical Resources (PR)**
1. Can the physical resources required by an individual process be defined?
2. Can physical resource responsibility be allocated?

**Patient Needs (PN)**
1. Does the method/technique provide for the definition of socio/economic patient needs?
2. Does the method/technique provide for the explicit definition of specific cultural and/or religious needs?
3. Can these be depicted on the PJ model?

**Administration (A)**
1. Can administration policies and guidelines associated with a process be documented?
2. Can they be shown on the PJ model?

**Practice Guidelines (PG)**
1. Can practice guidelines be associated with a process?

**Systems Data (SD)**
1. Does the method/technique allow for the definition of process data requirements? (Green and Rosemann 2000)
2. Can associated information systems be linked to a process?
3. Can information flows be shown on the PJ model?

**Measurements (M)**
1. Can operational process measurements be explicitly linked to strategic objectives? (Sicotte et al. 1998)
2. Can these links be depicted on the PJ model?
Technology Support (TS)

1. Has software been developed to support the method/technique?
2. Can the software provide output for the definition of operational workflows? (Swenson 1995)
3. Can the software provide output for the definition of variance analysis algorithms for decision support?
Appendix B
BSC XML Output –
Evaluate Patient Suitability
APPENDIX B - BSC XML FOR EVALUATE PATIENT SUITABILITY

The format for the Balanced Scorecard Perspective output is based on the Balanced Scorecard Collaborative XML Draft Standard (Balanced Scorecard Collaborative 2001). The BSC perspectives used for the case study are based on the Ontario Hospital Association enhancements discussed in Chapter 2; namely Patient Satisfaction, Clinical Utilisation and Outcomes, Systems Integration and Change and Financial Performance and Conditions (Ontario Hospital Association 1999). The particular objectives used in this example relate to the initial evaluation of a Patient’s suitability for the Ryde Midwifery Group Practice model of care from the time a woman requests an Assessment Questionnaire to the time her suitability is determined.

The following amendments have been made to this standard to facilitate its incorporation with PJM3.

1. A 'patientjourneymodel id' data element has been added to provide the ability to identify the treatment stream being modelled. This enables measures for a particular treatment stream to be explicitly linked to a specific Balanced Scorecard.

2. The 'type' data element within the ‘measure’ construct (as added by McGregor (2002)) has been extended to provide the ability to identify additional types of measures to be recorded. This includes ‘confidence level’ and ‘compliance’.

3. The 'unit' data element within the ‘measure’ construct has also been extended to accommodate for the new ‘types’ in point 2. This required the addition of a ‘percentage’ value.

4. Due to the individual working patterns associated with the Ryde Midwifery Group Practice model an additional extension was also required to the 'unit' data element within the ‘measure’ construct. This necessitated the addition of a ‘working day’ value.
The Balanced Scorecard (BSC) XML output for the Ryde Midwifery Group Practice case study – Patient Suitability Assessment component, as detailed in Chapter 5, is shown below. The additions to the BSC draft XML as detailed above are shown in bold.

```
<BSCDoc language="EN">
<BSC id="ISABSC" name="Initial Patient Suitability Assessment Balanced Scorecard">
<PATIENTJOURNEYMODEL Id="PJM01" name="RMGP Suitability Assessment Patient Journey Model">
    <PERSPECTIVE Id="PS01" name="Patient Satisfaction Perspective 1" PerspectiveType="Patient Satisfaction">
        <Description>Patient Satisfaction Perspective associated with Initial Suitability Assessments</Description>
        <OBJECTIVE Id="PSG1" name="Patient Satisfaction Goal 1" updateFrequency="Monthly" ownerRef="">
            <MEASURE Id="M01" name="Send Assessment Questionnaire to woman" type="cycle time" unit="hours" ownerRef="">
                <Description>Cycle time target from patient request for Assessment Questionnaire to dispatch</Description>
                <Target id="PSG1M01" Update Frequency="Monthly" TargetValue="24"/>
            </MEASURE>
        </OBJECTIVE>
    </PERSPECTIVE>
    <OBJECTIVE Id="PSG2" name="Patient Satisfaction Goal 2" updateFrequency="Monthly" ownerRef="">
```


<MEASURE Id="M02" name="Advice of Assessment Decision" type="cycle time" unit="hours" ownerRef="">
  <Description>Cycle time target from Suitability decision to patient notification</Description>
  <Target id="PSG1M02" Update Frequency="Monthly" TargetValue="72"/>
</MEASURE>
</OBJECTIVE>
</PERSPECTIVE>

<PERSPECTIVE Id="CUG01" name="Clinical Utilisation and Outcomes Perspective 1" PerspectiveType="Clinical Utilisation and Outcomes">
  <Description>Clinical Utilisation and Outcomes Perspective associated with Suitability Assessments</Description>
  <OBJECTIVE Id="CUOG1" name="Compliance with National Midwifery Guidelines Goal 1" updateFrequency="Monthly" ownerRef="NUM1">
    <MEASURE Id="M05" name="National Midwifery G/L Compliance" type="compliance" unit="percentage" ownerRef="">
      <Description>Percentage of suitability assessments conducted in accordance with the National Midwifery G/L for Consultation and Referral</Description>
      <Target Id="CUOG1M01" TargetValue="100"/>
    </MEASURE>
  </OBJECTIVE>
  <OBJECTIVE Id="CUOG2" name="Assessment Cycle Time from Receipt Goal 2" updateFrequency="Monthly" ownerRef="CLM1">
    <MEASURE Id="M06" name="Assessment Cycle Time" type="cycle time" unit="working day" ownerRef="">
      <Description>Maximum time from receipt of completed Assessment Questionnaire to suitability decision</Description>
      <Target Id="CUOG2M06" TargetValue="1"/>
    </MEASURE>
  </OBJECTIVE>
</PERSPECTIVE>

<PERSPECTIVE Id="SIC01" name="Systems Integration and Change Perspective 1" PerspectiveType="Systems Integration and Change">
  <Description>Systems Integration and Change Perspective associated with initial Suitability Assessments</Description>
  <OBJECTIVE Id="SICG1" name="Systems Integration and Change Goal 1" updateFrequency="Monthly" ownerRef="">
  </OBJECTIVE>
</PERSPECTIVE>
<MEASURE Id="M10" name="Suitability decision confidence level" type="confidence level" unit="percentage" ownerRef="">
  <Description>Confidence level of initial Suitability Assessment decisions</Description>
  <Target id="SICG1M10" Update Frequency="Monthly" TargetValue="90"/>
</MEASURE>
Appendix C
XPDL for Evaluate Patient Suitability
APPENDIX C - XPDL FOR EVALUATE PATIENT SUITABILITY

The format for the Process Definition Output shown in this Appendix is based on the Workflow Management Coalition XML Process Definition Language (XPDL) Standard V2.0 (WfMC 2005). This example represents the workflow design of a section of the Ryde Midwifery Group Practice (RMGP) Future Patient Journey Model (PJM) as detailed specified by PaJMa in Chapter 7.

Specifically the example demonstrates the section of the future PJM concerned with determining a patient’s suitability for care within the Ryde caseload midwife primary-care service (see page 1 of the model). NB: Additional sections of the future PJM would require definition for full implementation.

The following amendments are included in this standard to facilitate the modelling constructs of PaJMa.

3. Extended attributes have been defined within the 'activity' construct to denote a system activity for emailing the Assessment Questionnaire URL address to the patient’s nominated email address. For example:

```
<ExtendedAttributes>
    <ExtendedAttribute name="System Activity" value="Email"/>  
    <ExtendedAttribute name="Email">  
        <xyz:Email to="emailAddress" subject="Having your Baby at Ryde">  
            <xyz:Attachments>
                <xyz:Attachment>%%docURI</xyz:Attachment>
            </xyz:Attachments>
            <xyz:MessageText>Thankyou for your enquiry about 

            .......
            </xyz:MessageText>
        </xyz:Email>
    </ExtendedAttribute>
</ExtendedAttributes>
```
4. Within the 'activity' construct, extended attributes, as originally defined by McGregor (2002), have also been enhanced to provide links from the previously defined target Balanced Scorecard measurements to individual activities. For example:

```xml
<ExtendedAttribute>
  <Name>CUOG1</Name>
  <Value>CUOG1</Value>
</ExtendedAttribute>
<ExtendedAttribute>
  <Name>CUOColl1</Name>
  <Value>100</Value>
</ExtendedAttribute>
<ExtendedAttribute>
  <Name>CUOColl2</Name>
  <Value>CUOG2</Value>
</ExtendedAttribute>
<ExtendedAttribute>
  <Name>CUOColl3</Name>
  <Value>1</Value>
</ExtendedAttribute>
<ExtendedAttribute>
  <Name>SICColl2</Name>
  <Value>SICG2</Value>
</ExtendedAttribute>
<ExtendedAttribute>
  <Name>SICColl3</Name>
  <Value>90</Value>
</ExtendedAttribute>
```

The additions to the XPDL standard made for PaJMa are shown in bold. The use of McGregor’s original additions is shown in italics. Where McGregor’s (2002) original additions have been coupled with the enhancements made by this research, it is shown in bold italics.
<?xml version="1.0" encoding="us-ascii"?>
<Package xmlns:xpdl="http://www.wfmc.org/standards/docs/xpdl" id="Initial_Patient_Suitability_Assessment" Name="Evaluate Patient Suitability XPDL">
  <TypeDeclarations>
    <TypeDeclaration Id="Assessment_Questionnaire" Name="Assessment Questionnaire">
    </TypeDeclaration>
  </TypeDeclarations>
  <Participants>
    <Participant id="Manager1" name="Manager-1">
      <ParticipantType>HUMAN</ParticipantType>
      <Description>NurseUnitManager</Description>
    </Participant>
    <Participant id="WardClerk1" name="Ward Clerk-1">
      <ParticipantType>HUMAN</ParticipantType>
      <Description>Administration Clerk</Description>
    </Participant>
    <Participant id="CaseloadMidwife1" name="Caseload Midwife-1">
      <ParticipantType>HUMAN</ParticipantType>
      <Description>Named Midwife</Description>
    </Participant>
    <Participant id="CaseloadMidwife2" name="Caseload Midwife-2">
      <ParticipantType>HUMAN</ParticipantType>
      <Description>Named Midwife</Description>
    </Participant>
    <Participant id="CaseloadMidwife3" name="Caseload Midwife-3">
      <ParticipantType>HUMAN</ParticipantType>
      <Description>Named Midwife</Description>
    </Participant>
    <Participant id="CaseloadMidwife4" name="Caseload Midwife-4">
      <ParticipantType>HUMAN</ParticipantType>
      <Description>Named Midwife</Description>
    </Participant>
    <Participant id="CaseloadMidwife5" name="Caseload Midwife-5">
      <ParticipantType>HUMAN</ParticipantType>
      <Description>Named Midwife</Description>
    </Participant>
    <Participant id="NUM" name="Nurse Unit Mgr">
      <ParticipantType>ROLE</ParticipantType>
      <Description>manages maternity unit staff</Description>
    </Participant>
  </Participants>
</Package>
<Participant id="Ward_Clerk" name="Ward Clerk">
  <ParticipantType>ROLE</ParticipantType>
  <Description>performs initial patient contact</Description>
</Participant>

<Participant id="Caseload_Midwife" name="Caseload Midwife">
  <ParticipantType>ROLE</ParticipantType>
  <Description>performs suitability assessments</Description>
</Participant>

<Participant id="Maternity_Unit" name="Maternity">
  <ParticipantType>ORGANISATIONAL_UNIT</ParticipantType>
  <Description>provides physical clinical care and birthing space</Description>
</Participant>

<Participant id="Caseload_Team" name="Caseload Team">
  <ParticipantType>ORGANISATIONAL_UNIT</ParticipantType>
  <Description>provides actual clinical care and advice</Description>
</Participant>

<Participant id="Ryde_Maternity_DB" name="Ryde Maternity Database">
  <ParticipantType>SYSTEM</ParticipantType>
  <Description>integrated Ryde maternity database</Description>
</Participant>

<Participant id="Online_Assessment_Questionnaire_Application" name="Online Assessment Questionnaire">
  <ParticipantType>SYSTEM</ParticipantType>
  <Description>provides web-based assessment questionnaire for online completion and return</Description>
</Participant>

<Applications>
  <Application id="Ryde_Maternity_DB" name="Ryde Maternity Database">
    <Description>integrated Ryde maternity database</Description>
    <FormalParameters>
      <FormalParameter id="suitability_decision" mode="OUT">
        <DataType>String</DataType>
        <Description>identifies outcome of patient suitability evaluation</Description>
      </FormalParameter>
    </FormalParameters>
  </Application>
</Applications>
<DataFields>
  <DataField id="suitability_decision" name="Suitability Decision">
    <DataType>STRING</DataType>
    <InitialValue>Accept</InitialValue>
    <Length>10</Length>
    <Description>variable used to identify the outcome of the suitability evaluation</Description>
  </DataField>
</DataFields>
<WorkflowProcesses>
  <WorkflowProcess id="Evaluate_Patient_Suitability" name="Evaluate Patient Suitability">
    <FormalParameters>
      <FormalParameter Id="medicareNumber" Index="1" Mode="IN">
        <DataType><BasicType Type="INTEGER"/></DataType>
      </FormalParameter>
      <FormalParameter Id="patientName" Index="2" Mode="IN">
        <DataType><BasicType Type="STRING"/></DataType>
      </FormalParameter>
      <FormalParameter Id="emailAddress" Index="3" Mode="IN">
        <DataType><BasicType Type="STRING"/></DataType>
      </FormalParameter>
      <FormalParameter Id="patientPostalAddress" Index="4" Mode="IN">
        <DataType><BasicType Type="STRING"/></DataType>
      </FormalParameter>
    </FormalParameters>
    <Activities>
      <Activity id="Check_Medicare_Card" name="Medicare Card Check">
        <Implementation><NO/></Implementation>
        <Perfomer>Caseload_Midwife</Perfomer>
        <TransitionRestrictions>
          <TransitionRestriction><Split type="XOR"></Split></TransitionRestriction>
        </TransitionRestrictions>
      </Activity>
    </Activities>
  </WorkflowProcess>
</WorkflowProcesses>
<Activity id="Decide_A.Q._Dispatch_Method" name="Decide A.Q. Dispatch Method">
    <Implementation>
        <NO/>
    </Implementation>
    <Performer>Caseload_Midwife</Performer>
    <TransitionRestrictions>
        <TransitionRestriction>
            <Split type="XOR">
                <TransitionRefs>
                    <TransitionRef id="003"/>
                    <TransitionRef id="T_004"/>
                </TransitionRefs>
            </Split>
        </TransitionRestriction>
    </TransitionRestrictions>
</Activity>

<Activity id="Mail_A.Q._Information_Pack" name="Mail A.Q. Information Pack">
    <Implementation>
        <NO/>
    </Implementation>
    <Performer>Caseload_Midwife</Performer>
    <TransitionRefs>
        <TransitionRef id="005"/>
    </TransitionRefs>
    <ExtendedAttributes>
        <ExtendedAttribute>
            <Name>PSGoal1</Name>
            <Value>PSG1</Value>
        </ExtendedAttribute>
        <ExtendedAttribute>
            <Name>PSCycleTime</Name>
            <Value>24</Value>
        </ExtendedAttribute>
        <ExtendedAttribute>
            <Name>PSCycleTimeType</Name>
            <Value>Hours</Value>
        </ExtendedAttribute>
    </ExtendedAttributes>
<ExtendedAttribute>
  <Name>PSCycleTimeStartDate</Name>
  <Value>10/07/2007</Value>
</ExtendedAttribute>
<Activity id=Email_A.Q._URL_Address name="Email A.Q. URL Address">
  <Implementation>
    <NO/>
  </Implementation>
  <ExtendedAttributes>
    <ExtendedAttribute name="System Activity" value="Email"/>
    <ExtendedAttribute name="Email">
      <xyz:Email to="emailAddress"
        subject="Having Your Baby at Ryde">
        <xyz:Attachments>
          <xyz:Attachment>% %docURI</xyz:Attachment>
        </xyz:Attachments>
        <xyz:MessageText>Thankyou for your enqiry about birthing with the Midwives at Ryde Maternity. Please find attached an information pack outlining the care practices and services provided by our Midwives. To determine if you are a candidate for this service, please complete out Assessment Questionnaire at http://rydehosptial.gov.au/maternity/assessment.html. When you are finished “click” the "submit" button and your responses will be sent to Ryde for evaluation. A midwife will contact you within 48 hours to discuss the results. Regards The Ryde Maternity Team</xyz:MessageText>
      </xyz:Email>
    </ExtendedAttribute>
  </ExtendedAttributes>
  <Performer> Caseload_Midwife</Performer>
  <TransitionRefs>
    <TransitionRef id="006"/>
  </TransitionRefs>
  <ExtendedAttributes>
    <ExtendedAttribute>
      <Name>PSGoal1</Name>
      <Value>PSG1</Value>
    </ExtendedAttribute>
  </ExtendedAttributes>
</Activity>
<ExtendedAttribute>
  <Name>PSCycleTime</Name>
  <Value>24</Value>
</ExtendedAttribute>

<ExtendedAttribute>
  <Name>PSCycleTimeType</Name>
  <Value>Hours</Value>
</ExtendedAttribute>

<ExtendedAttribute>
  <Name>PSCycleTimeStartDate</Name>
  <Value>10/07/2007</Value>
</ExtendedAttribute>
</ExtendedAttributes>
</Activity>

<Activity id=Capture_Paper_Responses name="Paper Response Data Entry">
  <Implementation>
    <Task>
      <TaskApplication id="Capture Patient A.Q. Responses">
        <ActualParameters>
          <ActualParameter>patientName</ActualParameter>
          <ActualParameter>patientPostalAddress</ActualParameter>
          <ActualParameter>patientContactDetails</ActualParameter>
          <ActualParameter>patientPregnancyHistory</ActualParameter>
          <ActualParameter>patientMedicalHistory</ActualParameter>
          <ActualParameter>patientMedications</ActualParameter>
        </ActualParameters>
      </TaskApplication>
    </Task>
  </Implementation>

  <Performers>
    <Performer>Ryde_Maternity_DB_Application</Performer>
    <Performer>Caseload_Midwife</Performer>
  </Performers>

  <TransitionRestrictions>
    <TransitionRestriction>
      <TransitionRefs id="T_007"/>
    </TransitionRestriction>
  </TransitionRestrictions>
</Activity>
<Activity id="Make_Suitability_Decision" name="Patient Suitability Decision">
    <Implementation>
        <NO/>
    </Implementation>
    <Performer>Caseload_Midwife</Performer>
    <TransitionRestrictions>
        <TransitionRestriction>
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                <TransitionRefs>
                    <TransitionRef id="T_009"/>
                    <TransitionRef id="T_010"/>
                </TransitionRefs>
            </Split>
        </TransitionRestriction>
    </TransitionRestrictions>
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        <ExtendedAttribute>
            <Name>CUOGoal1</Name>
            <Value>CUOG1</Value>
        </ExtendedAttribute>
        <ExtendedAttribute>
            <Name>CUOCompliance</Name>
            <Value>100</Value>
        </ExtendedAttribute>
        <ExtendedAttribute>
            <Name>CUOComplianceType</Name>
            <Value>Percentage</Value>
        </ExtendedAttribute>
        <ExtendedAttribute>
            <Name>CUOGoal2</Name>
            <Value>CUOG2</Value>
        </ExtendedAttribute>
        <ExtendedAttribute>
            <Name>CUOCycleTime</Name>
            <Value>1</Value>
        </ExtendedAttribute>
        <ExtendedAttribute>
            <Name>CUOCycleTimeType</Name>
            <Value>WorkingDay</Value>
        </ExtendedAttribute>
        <ExtendedAttribute>
            <Name>SICGoal2</Name>
            <Value>SICG2</Value>
        </ExtendedAttribute>
        <ExtendedAttribute>
            <Name>SICConfidenceLevel</Name>
            <Value>90</Value>
        </ExtendedAttribute>
    </ExtendedAttributes>
<ExtendedAttribute>
   <ExtendedAttribute>
      <Name>SICConfidenceLevelType</Name>
   
   <Value>Percentage</Value>
</ExtendedAttribute>
</ExtendedAttributes>

<Activity id=Cature_Suitability_Decision name="Capture Suitability Decision">
   <Implementation>
      <Task>
         <TaskApplication id="Capture Suitability Decision">
            <ActualParameters>
               <ActualParameter>Suitability Decision</ActualParameter>
            </ActualParameters>
         </TaskApplication>
      </Task>
   </Implementation>
   <Performers>
      <Performer>Ryde_Maternity_DB_Application</Performer>
      <Performer>Caseload_Midwife</Performer>
   </Performers>
   <TransitionRestrictions>
      <TransitionRestriction>
         <Join type="XOR"/>
      </TransitionRestriction>
   </TransitionRestrictions>
   <Transitions>
      <Transition id="T_001" From="Medicare Card Check" To="Decide_A.Q._Dispatch_Method"/>
      <Condition type="CONDITION">
         <Expression 'Medicare_card_no'="True"/>
      </Condition>
   </Transition>
   <Transition id="T_002" From="Medicare Card Check" To="TERMINATE"/>
      <Condition type="CONDITION">
         <Expression 'Medicare_card_no'="False"/>
      </Condition>
   </Transition>
   <Transition id="T_003" From="Decide A.Q. Dispatch Method" To="Mail_A.Q._Information_Pack"/>
      <Condition type="CONDITION">
         <Expression 'email_address'="False"/>
      </Condition>
   </Transition>
   <Transition id="T_004" From="Decide A.Q. Dispatch Method" To="Email_A.Q._URL_Address"/>
   </Transitions>
   </Activity>
<Condition type="CONDITION">
  <Expression 'email_address'="True"/>
</Condition>

<Transition id="T_005" From="Mail A.Q. Information Pack" To="Input_Paper_Responses"/>

<Transition id="T_006" From="Email A.Q. URL Address" To="Make_Suitability_Decision"/>

<Transition id="T_007" From="Paper Response Data Entry" To="Make_Suitability_Decision"/>

<Transition id="T_008" From="Patient Suitability Decision" To="Capture_Suitability_Decision"/>

<Transition id="T_009" From="Patient Suitability Decision" To="Preliminary_Midwife_Assignment"/>
  <Condition type="CONDITION">
    <Expression 'suitability_decision'="Accept"/>
  </Condition>

<Transition id="T_010" From="Patient Suitability Decision" To="TERMINATE"/>
  <Condition type="CONDITION">
    <Expression 'suitability_decision'="Reject"/>
  </Condition>
</Transitions>
</WorkflowProcesses>
</Package>