UNIVERSITY OF KWAZULU-NATAL

PREDICTORS FOR THE SUCCESSFUL INITIATION OF LEAN IN SOUTH AFRICAN PUBLIC HOSPITALS: THE GENESIS OF THE 'LEAN SPRInT'

by

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This PhD is being conducted by publications. While the sections in the journal articles included in this thesis contain a Statement of Contribution by co-authors, this serves as a general declaration that the work of all articles included in this thesis are the original work of the PhD candidate Dr. Logandran Naidoo.

It is further declared that Prof. Ziska Fields and Dr. Evelyn Derera, in serving as supervisors of this PhD, have contributed in their supervisory role by providing overall guidance and advice for the journal articles, including the coherence of the contents of this thesis. Their contributions have been advisory and supervisory in nature; the writing of this work in its entirety was done by the PhD candidate, Dr. Logandran Naidoo.

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DEDICATION

Dedicated in loving memory

of my mother, Tholsiamma Naidoo,

who conveyed to me the value of

education, as encapsulated in the phrase

“Knowledge is Power”, and

to my little daughter, Dhyana Naidoo,

who will someday also comprehend

the value of this phrase.

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ABSTRACT

Introduction

Lean is a management approach which is suitable for improving efficiency in hospitals. However, the question of which critical success factors (CSFs) will predict the success of Lean initiation in public hospitals in KwaZulu-Natal is marginally described.

Research aim

The aim of the research was to identify the CSFs for Lean and to develop a Lean success predictor tool (Lean-SPRInT) for the initiation of Lean in public hospitals.

Methodology

An observational descriptive study employing simple random sampling was conducted across 73 KZN public hospitals. A semi-structured questionnaire was used. Key variables for Lean initiation were identified. Data were reduced using Exploratory Factor Analysis to identify latent constructs. Confirmatory Factor Analysis was used to determine the reliability and validity of these factors. Structural Equation Modelling fit indices were then applied to assess acceptability of the measurement model.

Results

A 96.8% (n=211) response rate was achieved. A significant 72% of managers have not heard of Lean before ($p<0.0005$). The results indicated scant knowledge of Lean ($t(56)=-7.353$; $p<0.0005$). Participants strongly felt that there was an opportunity for adopting Lean practices ($t=-12.800$; $df=188$; $p<0.0005$); and that Lean could possibly improve the operational performance in their hospitals ($t=-12.758$; $df=188$; $p<0.0005$). Three CSFs were identified: Strategic Leadership and Organisational Attitude; Integration of Lean Elements, Tools and Techniques; and Basic Stability in Operational Processes. All reliability and validity conditions have been met (RMSEA=0.085; CFI=0.956 and $\chi^2/df=2.513$). The CSFs were incorporated into the Lean SPRInT architecture. A Lean readiness level for each CSF is output along with recommendations, providing managers with a practical conduit for deploying resources.

Conclusion

The level of knowledge and experience of Lean is low amongst managers. Three CSFs have been identified for Lean initiation in hospitals. Lean SPRInT is recommended as a Lean success predictor tool that guides managers with initiating Lean in hospitals.

Practical and managerial implications of findings

Awareness of the baseline knowledge and experience of Lean amongst managers guides the focus and vehemence of Lean training initiatives. Lean SPRInT could be used as a launch tool for the systematic and wide-scale rollout of Lean in KZN public hospitals.

ACRONYMS AND ABBREVIATIONS

AIDS:	Acquired Immune Deficiency Syndrome
AMOS:	Analysis of a Moment Structures
AVE:	Average Variance Extracted
CEO:	Chief Executive Officer
CFA:	Confirmatory Factor Analysis
CFI:	Comparative Fit Index
CR:	Composite Reliability
CSF:	Critical Success Factor
DBSA:	Development Bank of South Africa
DDG-SSCS:	Deputy Director General: Specialised Services and Clinical Support
df:	Degrees of Freedom
DHET:	Department of Higher Education and Training
DHS:	District Health System
EFA:	Exploratory Factor Analysis
HEARD:	Health Economics and HIV/AIDS Research Division
HIV:	Human Immuno-deficiency Virus
HLA:	Healthcare Lean Assessment
HRKM:	Health Research and Knowledge Management Unit
HSSREC:	Human Social Sciences Research Ethics Committee
KZN:	KwaZulu-Natal
Lean:	Lean thinking
NHI:	National Health Insurance
OPD:	Outpatient Department
PDCA:	Plan, Do, Check, Act
PHC:	Primary Health Care
RMSEA:	Root Mean Square Error of Approximation
SEM:	Structural Equation Modelling
SME:	Small to Medium Enterprise
SPRInT:	Success Predictor for Rapid Initiation Tool
SPSS®:	Statistical Package for the Social Sciences
Stats SA:	Statistics South Africa
TPS:	Toyota Production System
UK:	United Kingdom
UKZN:	University of KwaZulu-Natal
US:	United States (of America)
VSM:	Value Stream Map
WHO:	World Health Organisation

TABLE OF CONTENTS

SUPERVISORS' PERMISSION TO SUBMIT THESIS FOR EXAMINATION ii

DECLARATION 1: ORIGINAL WORK iii

DECLARATION 2: PUBLICATIONS iv

DEDICATION v

ACKNOWLEDGEMENTS vi

ABSTRACT vii

ACRONYMS AND ABBREVIATIONS ix

TABLE OF CONTENTS x

List of Figures (excluding Figures in Articles) xviii

List of Tables (excluding Tables in Articles) xix

1. CHAPTER ONE: INTRODUCTION 1

1.1 Preamble 1

1.2 Background of the Study 2

1.3 Research Problem 4

1.4 Research Question 5

1.5 Research Aim and Objectives 6

1.6 Conceptual Framework 6

1.7 Significance and Contribution of the Study 8

1.8 Rationale/ Justification of the Study 10

1.9 Limitations and Delimitations of the Study 11

1.9.1 Limitations 11

1.9.2 Delimitations 12

1.10 Layout and Framework of the Thesis 12

1.11 Summary 17

2. CHAPTER TWO: LEAN THINKING IN HEALTH CARE - A REVIEW OF LITERATURE 18

2.1 Introduction 18

2.2 Approach to the Literature Review 18

2.3 The Organisational Strategy Road Map: The Intervention-implementation Gap 19

2.4 Organisational Vision and Strategy: The South African Health-care Landscape 20

2.5 Operational Efficiency as an Enabler of Organisational Success 25

2.6 Barriers to Operational Efficiency in South African Health-care Facilities 27

2.7 An Introduction to Lean thinking: A Novel Solution to Operational Inefficiency 29

2.8 The Principles of Lean Thinking 30

2.9 Lean Concepts, Tools and Techniques 30

2.9.1 PDCA cycle 31

2.9.2 Kaizen teams 32

2.9.3 Value-stream map 32

2.9.4 A3 report 33

2.9.5 5-Why 34

2.9.6 5-S 37

2.10 The Worldwide Context of Critical Success Factors for Lean 38

2.11 The Health-care Context of Critical Success Factors for Lean 38

2.12 Narrowing the Intervention-implementation Gap 40

2.13 Pitfalls and Gaps in Existing and Reviewed Literature 41

2.14 How the Study Addresses Pitfalls and Gaps of Past Research 42

2.15 Summary 43

3. CHAPTER THREE: RESEARCH METHODOLOGY 44

3.1 Introduction 44

3.2 Research Process 45

3.3 Research Philosophies or Paradigms 47

3.3.1 Positivism 47

3.3.2 Realism 48

3.3.3 Interpretivism 49

3.3.4 Pragmatism 49

3.3.5 Comparing the research philosophies 50

3.3.6 Research philosophy for this study 50

3.4 Research Approaches 51

3.4.1 Deductive research approach 52

3.4.2 Inductive research approach 52

3.4.3 Abductive research approach 53

3.4.4 Research approach used in this study 53

3.5 Research Methodological Choices 54

3.5.1 Mono method 55

3.5.2 Multiple methods 55

3.5.3 Mixed methods 56

3.5.4 Mixed-model research 57

3.5.5 Research methodological choice adopted for this study 57

3.6 Research Strategies 57

3.6.1 Experimental studies 58

3.6.2 Quasi-experimental studies 59
3.6.3 Surveys 59
3.6.4 Exploratory studies 59
3.6.5 Descriptive studies 60
3.6.6 Explanatory studies 61
3.6.7 Case studies 62
3.6.8 Ethnographic studies 62
3.6.9 Action research 64
3.6.10 Grounded theory 65
3.6.11 Archival research 66
3.6.12 Research strategies adopted for this study 66
3.7 Time Horizon 68
3.7.1 Cross-sectional studies 68
3.7.2 Longitudinal studies 68
3.8 Study Site and Target Population 69
3.9 Inclusion and Exclusion Criteria 71
3.10 Sampling Technique 71
3.10.1 Probability (or random) sampling 73
3.10.2 Non-probability sampling 74
3.10.3 Sampling techniques used in this study 75
3.11 Sample size 77
3.12 Data-collection Methods 78
3.12.1 Research instrument 78
3.12.2 Advantages and challenges with using the research instrument 80

3.12.3 Data-collection process 80
3.13 Data Analysis 83
3.13.1 Descriptive statistics 83
3.13.2 Cronbach's alpha coefficient 84
3.13.3 Factor analysis 84
3.13.4 Structural Equation Modelling.. 84
3.14 Ethical Considerations 85
3.15 Summary 86
4. CHAPTER FOUR: ARTICLE 1: AN OVERVIEW OF CRITICAL SUCCESS FACTORS FOR LEAN IMPLEMENTATION IN HEALTH CARE 87
4.1 Introduction.. 87
4.2 Article submitted to journal 88
4.3 Conclusion 109
5. CHAPTER FIVE: ARTICLE 2: KNOWLEDGE AND EXPERIENCE OF LEAN AMONGST SENIOR HEALTH-CARE MANAGERS IN PUBLIC HOSPITALS IN KWAZULU-NATAL 110
5.1 Introduction.. 110
5.2 Article submitted to and accepted by journal for publication................................ 111
5.3 Conclusion 132
6. CHAPTER SIX: ARTICLE 3: DETERMINING THE CRITICAL SUCCESS FACTORS FOR THE SUCCESSFUL INITIATION OF LEAN THROUGH FACTOR ANALYSIS AND STRUCTURAL EQUATION MODELLING 134
6.1 Introduction.. 134
6.2 Article published in Human Resources for Health Journal 135
6.3 Conclusion 162

7. CHAPTER SEVEN: ARTICLE 4: THE DEVELOPMENT OF THE LEAN SUCCESS PREDICTOR FOR RAPID INITIATION TOOL (LEAN SPRInT) 163

7.1 Introduction 163

7.2 Article submitted to journal 164

7.3 Conclusion 198

8. CHAPTER EIGHT: ARTICLE 5: THE DEPLOYMENT OF LEAN SPRInT: A MANAGEMENT TOOL FOR INITIATING LEAN IN PUBLIC HOSPITALS IN KWAZULU-NATAL 199

8.1 Introduction 199

8.2 Article published in Journal of Contemporary Management 200

8.3 Conclusion 230

9. CHAPTER NINE: CONCLUSION AND RECOMMENDATIONS 231

9.1 Introduction 231

9.2 Conclusions (in terms of Objective 1): Current Knowledge and Experience of Lean Amongst Senior Health-care Managers 232

9.3 Conclusions (in terms of Objectives 2 and 3): Key Variables and Critical Success Factors which Predict the Successful Initiation of Lean in Public Hospitals 233

9.4. Conclusions (in terms of Objective 4): Developing a Lean Success Predictor for Rapid Initiation Tool (Lean SPRInT) using Identified CSFs 235

9.5 Recommendations 236

9.5.1 Introduction 236

9.5.2 Recommendations in terms of Objective 1 (baseline knowledge and experience of Lean amongst managers) 236

9.5.3 Recommendations in terms of Objective 2 and Objective 3 (identified variables and CSFs for Lean initiation) 237

9.5.4 Recommendations in terms of Objective 4 (the genesis of the Lean SPRInT) 238

9.5.5 Recommendations in terms of wide-scale Lean SPRInT deployment 239
9.6 Areas for Further Research 240
9.7 Summary 241
9.8 Overall Conclusion and Unique Contribution of the Study 243
REFERENCES 244
ANNEXURES 266
Annexure A: Information Sheet and Informed consent 266
Annexure B: Research Questionnaire 270
Annexure C: KZN Department of Health Letter of Permission 274
Annexure D: Letter of Permission from KZN Department of Health Deputy Director General: Specialised Services and Clinical Support 275
Annexure E: Final Ethics Approval 277
Annexure F: Ethics approval re-certification 278
Annexure G: Amended Ethics Approval for Addition of Co-Supervisor 279
Annexure H: Letter of Permission from Gatekeeper for Publication of Results 280
Annexure I: Proof of submission of Article 1 to South African Health Review journal 281
Annexure J: Proof of acceptance of Article 2 for publication in SPOUDAI Journal of Economics and Business 282
Annexure K: Proof of publication of Article 3 in Human Resources for Health (Reference number HRHE-D-18-00059R3) 283
Annexure L: Proof of submission of Article 4 to South African Business Review .. 284
Annexure M: Proof of publication of Article 5 in Journal of Contemporary Management (JCM 19-030) 285

Annexure N: Permission from Journal of Contemporary Management to use copyright article in thesis 286

Annexure O: Permission from Human Resources for Health to use article in thesis 287

Annexure P: Table of sample sizes based on desired accuracy or confidence levels 288

Annexure Q: Confirmation of proofreading and professional editing of thesis 289

Annexure R: Turnitin Report 290

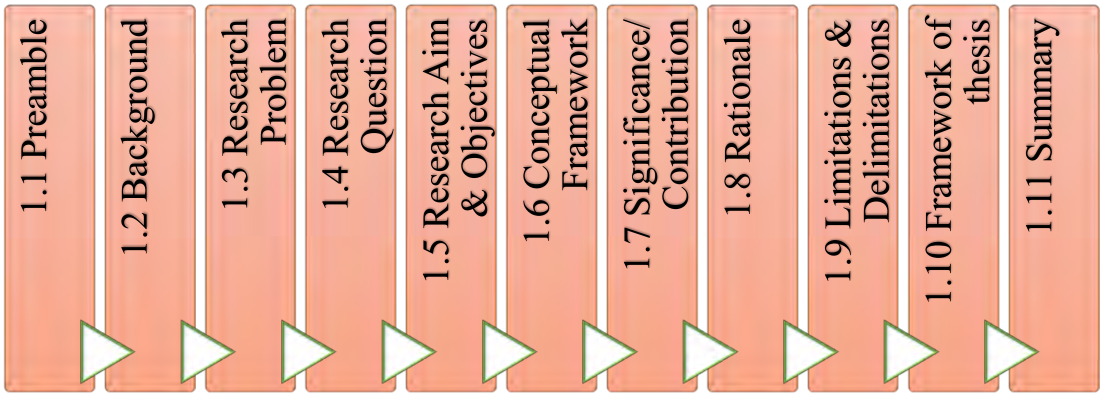
List of Figures (excluding Figures in Articles)

Figure 1.1: Model for relationship between critical success factors and success indicators of Lean in the manufacturing industry 7
Figure 1.2: A conceptual framework for current study 8
Figure 1.3: Framework of the thesis 13
Figure 2.1: Intervention-implementation gap in the organisational strategy roadmap 19
Figure 2.2: The 5 strategic goals and 8 programmes of the KZN Department of Health 21
Figure 2.3: A systems framework for health-care efficiency 25
Figure 2.4: Fault lines in the South African health sector 29
Figure 2.5: Preliminary steps leading to the utilization of PDCA cycles 32
Figure 2.6: Example of an A3 tool template 35
Figure 2.7: Example of a Value Stream Map 36
Figure 2.8: The 5S technique 37
Figure 3.1: The research onion model 45
Figure 3.2: The research process used in this study 46
Figure 3.3: Inductive and deductive reasoning 48
Figure 3.4: Research methodological choices 54
Figure 3.5: Characteristics of ethnographic research 63
Figure 3.6: The relationship between the key processes of grounded theory research ... 65
Figure 3.7: Sampling techniques 72
Figure 3.8: Advantages and disadvantages of the sampling techniques 72

List of Tables (excluding Tables in Articles)

Table 2.1: National Development Plan Vision 2030, Priorities 2030 and National Department of Health goals 2014-2019 22
Table 2.2: Examples of KwaZulu-Natal Department of Health Operations or Systems Management-related Priorities 2018-2019 23
Table 2.3: Alignment of KZN Department of Health Strategic Goals with Relevant Macro Plans 24
Table 2.4: Examples of the Seven Wastes (Type 2 non-value-added work) in Health Care 31
Table 2.5: Content of an A3 Report 34
Table 2.6: Research Landscape showing Identified Critical Success Factors 39
Table 3.1: Comparison of the Research Philosophies 51
Table 3.2: A Typology of Mixed Methods Research Designs 56
Table 3.3: Characteristics of Case Studies 63
Table 3.4: Strengths and Weaknesses of using Secondary Data or Archival Sources 66
Table 3.5: Study Site and Population 69
Table 3.6: Public Health Facilities in KwaZulu-Natal 70
Table 3.7: Factor Analysis Sample Sizes in Current Practice 77
Table 3.8: Structural Equation Modelling (SEM) Non-centrality-based Fit Indices 82
Table 3.9: Squared Correlations, Composite Reliability, Average Variance extracted and Cronbach's Alpha for Current Model 83

1. CHAPTER ONE: INTRODUCTION



1.1 Preamble

A challenging milieu for health-care delivery in South Africa, in view of its quadruple burden of disease, is compelling enough for health-care managers to embrace modern approaches of management effective in environments with limited resources (Coovadia, Jewkes, Barron, Sanders and McIntyre, 2009; Mayosi and Benatar, 2014; Whiteside, 2014). Recent emphasis has been placed on health-system strengthening for improving quality of health care. However, admittedly, these quality improvement initiatives have been “uncoordinated and minimally monitored”, claims the Office of Health Standards Compliance, an independent body established in South Africa to regulate the quality of services in the public health sector (Moleko, Msibi and Marshall, 2014; SARRAH, 2013; World Health Organisation, 2007b).

Lean is a highly reputable management approach employed to identify and successfully resolve operational problems, providing better health care to patients, while reducing inefficiency and cost (Bliss, 2009; Zidel, 2006b). With the pressing need for quality improvement in a crisis-ridden health-care sector in the country (Gilson and Daire, 2011), this is an opportune time to investigate the critical success factors (CSFs) for initiation of Lean in South African public institutions.

The successful implementation of Lean in an organisation is dependent on the degree of conformance with CSFs. Identifying and understanding the CSFs for Lean implementation in South African public hospitals is a prelude to effectively employing Lean as a management approach for improving organisational efficiency.

Furthermore, an appreciation of the current status of health-care managers' knowledge, skills, and attitudes towards adopting Lean, is fundamental in determining how vociferously leaders should embark on such a venture.

This study endeavoured to acquire the baseline level of knowledge and attitude towards Lean amongst senior health-care managers; to determine the variables for Lean initiation in public hospitals; and to conduct factor analysis and structural equation modelling on these variables to derive CSFs. In so doing, the researcher was able develop a practical Lean success predictor tool (Lean Success Predictor for Rapid Initiation Tool or Lean SPRInT) by employing the CSFs in an electronic tool. This tool can be adopted for predicting the success or failure of Lean initiation for swift roll-out thereof in KwaZulu-Natal public hospitals, and possibly in the rest of South Africa.

1.2 Background of the Study

South African public health-care facilities face a variety of operational management issues, partly owing to two key groups of limitations. One of these, cited in the Development Bank of South Africa's (DBSA) 2008 'Road Map' report, and by Gilson and Daire (2011), is related to the challenges in policy implementation (Development Bank of Southern Africa, 2008; Gilson and Daire, 2011). Some new policies have antagonistically caused more barriers to health care, defeated equity promotion, and undermined quality of care and health-provider motivation (Gilson and Daire, 2011). The other significant limitation relates to the culture and organisational structures entrenched in the public health-care system (Gilson and Daire, 2011).

Health-care managers in South Africa are inevitably obliged to adopt avantgarde approaches of management for the efficient delivery of health care services in environments with limited resources. This is in the face of the country's "quadruple burden of disease", namely, communicable disease, non-communicable disorders, maternal and perinatal disorders, and injury-related conditions (Coovadia *et al.*, 2009; Mayosi and Benatar, 2014; Whiteside, 2014).

Although it is acknowledged that health-systems strengthening is required for quality improvement, the Office of Health Standards Compliance reports that improvement initiatives are "uncoordinated and minimally monitored" (Moleko *et al.*, 2014; SARRAH, 2013; World Health Organisation, 2007b).

In order to achieve sustainable recuperation in the delivery of health care, with limited resources, and with recently meagre economic growth outlook, efforts have to be made toward improved health-care management and "doing better with less" (Mayosi and Benatar, 2014). Lean is one such fast-growing approach which uses tools and techniques that are easily adaptable and suitable for application in public hospitals.

Lean identifies and minimises wasteful process activities by addressing operational problems while reducing inefficiency and cost (Bliss, 2009; Zidel, 2006b). The principal focus of Lean is waste reduction, as well as synchronizing and addressing process flows which have high variability. However, the knowledge, experience, and implementation thereof amongst public health-care managers is not well understood. Furthermore, no framework currently exists in South Africa for the successful initiation of Lean in public health-care institutions. Having a better understanding of the depth and extent of knowledge, experience, and perceptions of Lean amongst senior health-care managers would enable the identification of requisites and the development of a tool for the successful implementation of this management philosophy that is renowned in several countries and industries worldwide.

For the purpose of this study, the term "*successful initiation"* of Lean implies a continuous and enduring application of Lean principles, tools, and techniques in the organisation, over at least 6 months, which employees embrace as a management approach; and which yields positive results for well-defined success indicators.

With the pressing need for quality improvement in the public health-care sector (Gilson and Daire, 2011), especially with the proposed National Health Insurance project nearing its start, this is an opportune time to investigate and report on the requisites for initiation of Lean in South African public hospitals.

1.3 Research Problem

A vast range of operational management problems exist in public health-care institutions in South Africa which are described as in “a state of crisis”, with decrepit infrastructure and dysfunctional hospitals, partially as a result of mismanagement (Mayosi and Benatar, 2014; von Holdt and Murphy, 2007). The National Development Plan (2012) also acknowledged uneven and poor performance amongst state institutions (National Planning Commission, 2012). It is argued that “*…new forms of middle manager (and wider) leadership are required to nurture collective sense-making … goals and empower front line health staff to take ownership of these goals, and so exercise their discretionary power in their pursuit*” (Gilson, Elloker, Olckers and Lehmann, 2014: 12).

Proponents for systems thinking and leadership transformation suggest that a fundamental change in the way in which health-system actors work is needed to meet, *inter alia*, Primary Health Care strengthening goals (Gilson *et al.*, 2014). Empowering frontline workers is only one of the leadership changes that is required to shape behaviour, by thinking and working differently, in order to meet service-delivery objectives.

It appears that many health-care managers in public health institutions in KZN do not use any particular systematic management approach to address operational and strategic issues in their institutions, thus possibly contributing to stagnation or poor results of key performance indicators (Gilson and Daire, 2011; Gilson *et al.*, 2014; National Planning Commission, 2012; von Holdt and Murphy, 2007).

The absence of reliable information on the prevailing knowledge of management approaches, in particular of Lean, that exists amongst health-care managers in KZN public hospitals, muddles and stifles any potential starting point for the rollout of such an approach. Moreover, the adoption of Lean is unlikely to succeed without awareness and understanding of its critical success factors.

The baseline level of knowledge and awareness of Lean amongst health-care managers and the identification of Lean CSFs are essential for the successful adoption and implementation of Lean. Even though managers oblivious to this study may attempt the implementation of Lean in their hospitals, research has shown that the failure rate is high in the absence of systems thinking, and a pragmatic implementation approach (Gilson and Daire, 2011; von Holdt and Murphy, 2007).

In an attempt to solve the research problem, the researcher was able to develop a practical, electronic Lean success predictor tool (Lean Success Predictor for Rapid Initiation Tool or Lean SPRInT) by employing CSFs identified in the study. This tool could be adopted for predicting the success or failure of Lean initiation, for the swift roll-out thereof in public hospitals in KwaZulu-Natal.

1.4 Research Question

The key research question that had to be answered was: What are the CSFs that will predict successful Lean initiation in public hospitals in KwaZulu-Natal, South Africa?

The research sub-questions which the research findings addressed were:

- What is the current knowledge, experience, and perceptions of Lean amongst senior health-care managers in public hospitals in KwaZulu-Natal?
- What are the key variables for the expeditious and successful initiation of Lean in public hospitals across KwaZulu-Natal?
- How can factor analysis and structural equation modelling (SEM) be applied to the key variables to identify CSFs which predict the successful initiation of Lean?
- In what way can the CSFs be used to develop a practical, electronic Lean initiation success predictor tool (Lean SPRInT)?

1.5 Research Aim and Objectives

The aim of the research was to identify CSFs for Lean initiation, utilising them to develop a Lean success predictor tool (Lean SPRInT) for the initiation of Lean in public hospitals across KwaZulu-Natal, South Africa.

The key research objectives were:

1. To describe the knowledge, experience, and perceptions of Lean amongst senior health-care managers in public hospitals in KwaZulu-Natal;
2. To identify the key variables for the successful initiation of Lean in public hospitals in KwaZulu-Natal;
3. To conduct factor analysis and structural equation modelling (SEM) on the key variables leading to the identification of CSFs for Lean initiation; and
4. To utilise these CSFs in the development of the lean success predictor for rapid initiation tool (Lean SPRInT) for the successful initiation of Lean.

1.6 Conceptual Framework

It is suggested that a conceptual framework should be employed when multiple theories and findings are used to develop concepts and to guide research (Parahoo, 2006). Even though the terms "theoretical framework" and "conceptual framework" are used interchangeably by some authors, it is far more important to determine how concepts and theory can be used to underpin the current study (Green, 2014; Parahoo, 2006). The researcher has adopted concepts derived from a seminal study by Vermaak (2008), investigating the relationship between critical success factors for Lean implementation, and its success indicators in the manufacturing sector (Figure 1.1). In doing so, a conceptual framework for the current study was developed (Figure 1.2).

Vermaak (2008:183) established from extensive literature review that the independent variables considered as CSFs for Lean implementation in the production industry can be categorised as follows: attitude and mindset, strategic drivers, basic stability, ordinary employees, leadership, tools and techniques, Lean promotion office, and integration. The researcher, with permission, utilised the same categories of variables in the research questionnaire. The difference, however, was that these independent variables would not yet be labelled "critical success factors" until a factor analysis and structural equation modelling was carried out. The independent variables for the development of the research questionnaire were adapted, with permission, from Vermaak's (2008) research. Once the critical success factors (dependent variables) had thereafter been identified, they were incorporated into the development of the Lean SPRInT.

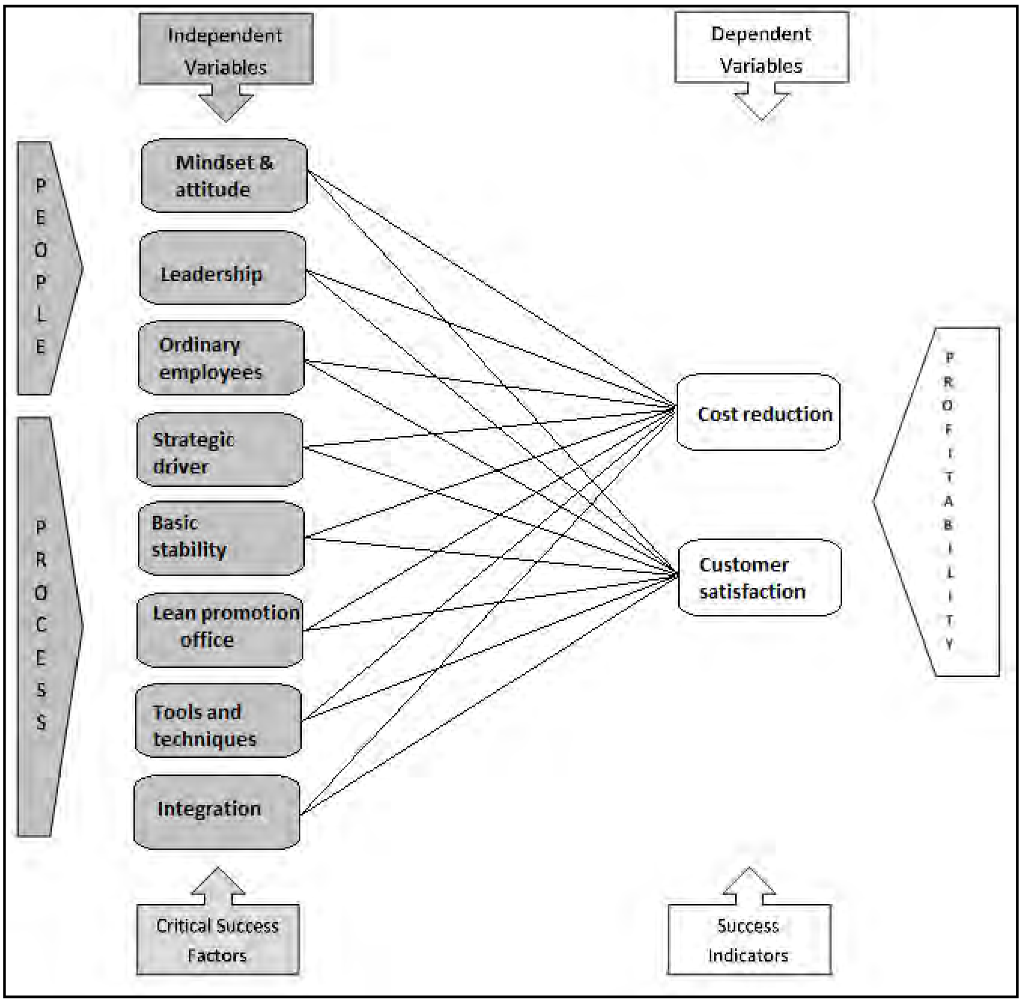


Figure 1.1: Model for relationship between critical success factors and success indicators of Lean in the manufacturing industry

Source: Vermaak (2008).

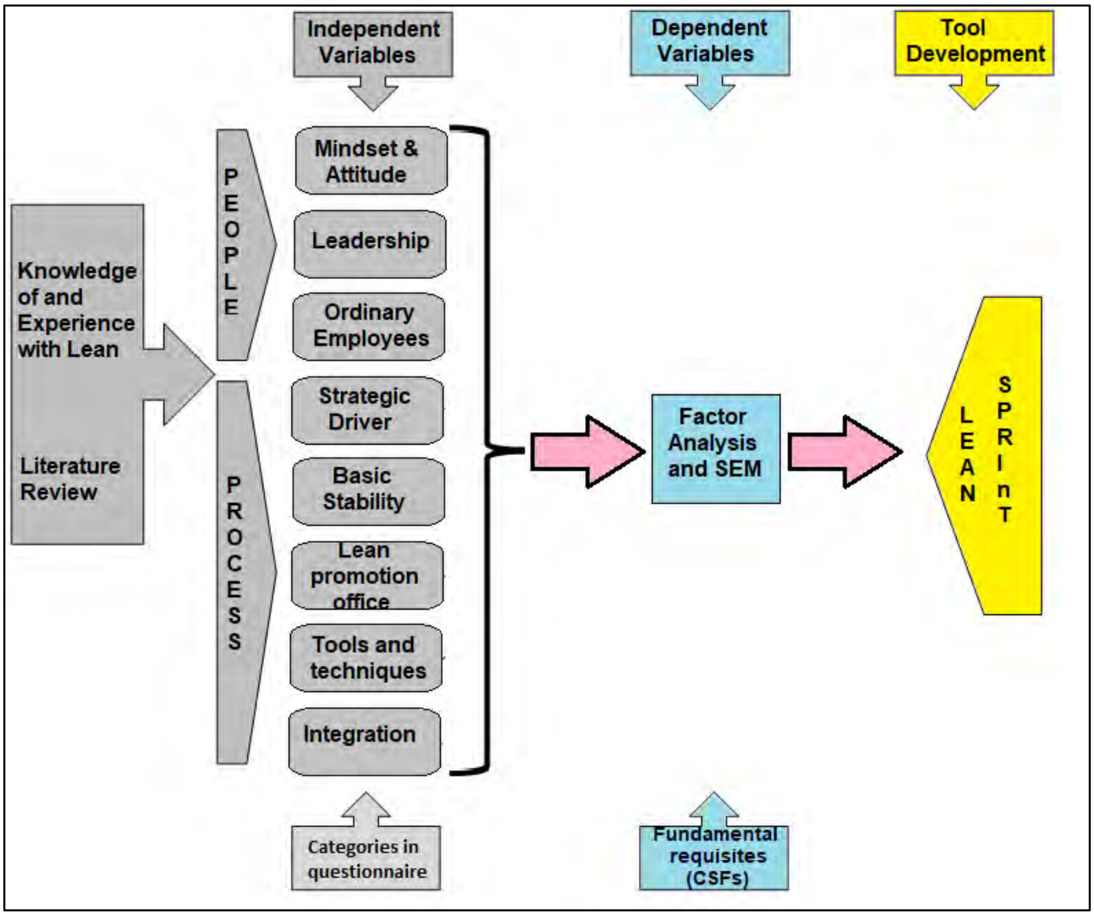


Figure 1.2: A conceptual framework for current study

Source: Author developed.

1.7 Significance and Contribution of the Study

Firstly, by identifying the baseline knowledge, experience, and perceptions of Lean thinking amongst senior health-care managers, one could establish the degree to which training programmes levelled at initiating and increasing the practice of Lean could be pitched. Furthermore, the identified critical success factors for Lean initiation would be scientifically credible, as they would have undergone rigorous statistical modelling against a backdrop of extensive literature review, and an in-depth survey conducted on the actual managers targeted for future adoption and use of Lean SPRInT.

Lean SPRInT could be used as an innovative means for the rapid but systematic initiation of Lean as a novel operations-management approach in public hospitals across KwaZulu-Natal. This could result in widespread adoption of the practice of Lean by health-care managers both in the public and private sectors nationwide. Such may ultimately lead to improvements in patient waiting times, cycle times, patient value streams, staff satisfaction, and other output and outcome indicators that are well-documented in literature, even with limited or fewer resources (Ben-Tovim *et al.*, 2007; DelliFraine, Langabeer and Nembhard, 2010; Faull and Booysen, 2007; Naidoo, 2013; Naidoo and Fields, 2015).

Lean SPRInT contains the variables of the critical success factors (in a Likert-scale assessment form) which predict success for Lean initiation in public hospitals. Upon completion of the tool, managers would be able to predict the success or failure of Lean, given their existing resources, processes, and skillset inheritance. The tool was developed on Microsoft Excel® and consists of a list of critical success factor elements. Based on the user's inputs on a Likert-scale for each statement, the tool calculates a score. The tool then informs the manager of the potential for success or failure of Lean initiation, as well as a list of gaps that need to be addressed to envisage success.

Since Lean aims to 'achieve more with less', even in systems with high variability such as hospitals, this could result in greater achievement of health-care objectives and outcomes, with better process efficiencies at facility level. Health-care managers may attempt the implementation of Lean within their institutions in the absence of a success predictor tool, but research has shown that the failure rate is high in the absence of a pragmatic implementation approach (Burgess and Radnor, 2013; Gilson and Daire, 2011; Vermaak, 2008). This research additionally aimed to develop a success predictor tool for the swift initiation of Lean, which would expedite the implementation process in KZN hospitals.

1.8 Rationale/ Justification of the Study

Based on the Global Burden of Disease Study of 2015 and 2017, it has been reported that low and middle-income countries endure "severe resource limitations but the highest burden of disease" (GBD 2015 Mortality and Causes of Death Collaborators, 2016: e1376; Gouda *et al.*, 2019). Addressing this problem necessitates the delivery of health-care services in the most efficient manner (Watson, Sahota, Taylor, Chen and Lilford, 2018). Doherty (2010:818) argues that optimal "performance of the health system is… about improving technical efficiency" (Doherty, 2010: 818). The Office of Health Standards Compliance (OHSC) claims that quality improvement initiatives vis-à-vis efficiency improvements are largely "uncoordinated and minimally monitored" (Moleko *et al.*, 2014; SARRAH, 2013; World Health Organisation, 2007b). Mayosi and Benatar (2014) emphasise the need for doing more with less in the drive to improving health care within the country (Mayosi and Benatar, 2014).

Lean has been recognised as a "sociotechnical system… which comprises a package of management practices" that accords the urges of the OHSC and other health-system experts with the goal of improving efficiency (Mostafa, Dumrak and Soltan, 2013: 44). Lean can be used to identify and successfully address operational problems, while reducing inefficiency and cost (Bliss, 2009; Zidel, 2006b).

Despite the need for rolling out Lean in public hospitals, the knowledge, experience and implementation thereof amongst public health-care managers in KZN is not well understood. It has further been purported that there is lack of research on CSFs and readiness for Lean initiation (Al-Najem, 2014). Mostafa *et al*. (2013: 47) affirm that Lean implementation efforts are most successful when they are launched as frameworks or roadmaps. The CSFs for Lean initiation in KZN public hospitals are unknown, and there is currently no framework or roadmap for Lean initiation in KZN public hospitals. Accordingly, establishing the baseline knowledge, experience, and perceptions of Lean amongst health-care managers, and identifying Lean CSFs for incorporation into a readiness assessment tool and Lean implementation framework, is indisputable.

This study was crucial because it elucidated the baseline knowledge, experience, and perceptions of Lean amongst public health-care managers in KZN. This point of departure is important. The knowledge of Lean and its tools and techniques, as well as the attitude of managers towards Lean adoption, determines the level at which to pitch training efforts for wide-scale Lean implementation. Acquiring this information also guides the pace and vehemence for Lean roll-out.

Analysing the variables for successful Lean implementation led to the identification of success predictors and development of a scientifically scrutinised tool for the rapid initiation of Lean. Such a tool is important to provide a starting point for managers wanting to initiate Lean within their organisations. Had this research not been conducted, the adoption of Lean in public health-care institutions in KwaZulu-Natal could be erratic, unsystematic, slow, or completely absent, resulting in persisting management apathy and outcome failures in a crisis-ridden sector.

1.9 Limitations and Delimitations of the Study

1.9.1 Limitations

The researcher experienced difficulty in reaching the participants, and delayed response times, owing to the wide geographical spread of the public hospitals, some with information technology and network difficulties. There were also some management posts that were vacant, with high staff-turnover rate, often with people erratically acting in those positions. Some managers did not initially return their signed informed consent forms to the researcher; and this had to be followed up constantly. The distribution of responses amongst the different subgroups of managers was uneven, owing to the lack of interest shown by some managers to participation in the study.

Most of these limitations were addressed by close collaboration with the local health district offices and hospital managers. A dedicated research assistant was also used to distribute and collect questionnaires and to follow up on responses from participants. This assistant was paid a stipend; and worked approximately 20-25 hours per week during the data-collection process.

Funding for the research, and specifically for development of the electronic Lean SPRInT, was limited, resulting in a basic tool being developed using Microsoft Excel®. The tool nevertheless accomplishes what it was intended to achieve.

1.9.2 Delimitations

The researcher chose to conduct the study in KZN public hospitals, and deliberately excluded Community Health Centres (CHCs) and Primary Health Care Clinics (PHCCs). The reasons for this were as follows:

- KZN was chosen as the province within which to conduct the study because the province is in dire need of efficiency improvement, having some of the worst audit outcomes, and fruitless and wasteful expenditure compared with other provinces in the country (KZN Department of Health, 2018b). Some other provinces have already begun the roll-out of Lean, however, KZN is falling behind.
- The intention of the research was to focus the enquiry on hospitals for the identification of the CSFs with the anticipation of Lean initiation in KZN public hospitals. CHCs and PHCCs were excluded. These facilities often lack a full executive management team, and are nevertheless represented and supported by their respective mother hospitals, or district offices.

Managers working in the KZN Provincial Head Office and District Offices were excluded from the study; they were not part of the population of interest for this study. The focus of enquiry was on managers in hospitals (service-delivery points) where it is anticipated that Lean should be rolled out. Any participant who declined participation in the study was also excluded.

1.10 Layout and Framework of the Thesis

This thesis is presented in nine chapters. It adopts the “doctoral degree by published research papers” format, as specified by the University of KwaZulu-Natal. The structure of the thesis is illustrated in Figure 1.3. Thus, the thesis contains an introductory chapter, a literature review chapter, a separate chapter on research methodology, five individual chapters consisting of five interrelated and coherent but distinct research articles, and a conclusion and recommendations chapter. Each research article contains its own abstract and bibliography specific to the requirements of the journal in which it was published or to which it was submitted. The sequence of numbering tables and figures within each article (Chapters 4 to 8) is specific for that article. It does not adhere to the sequence of numbering tables and figures in the rest of the thesis. A concise summary of each chapter of the thesis is provided below.

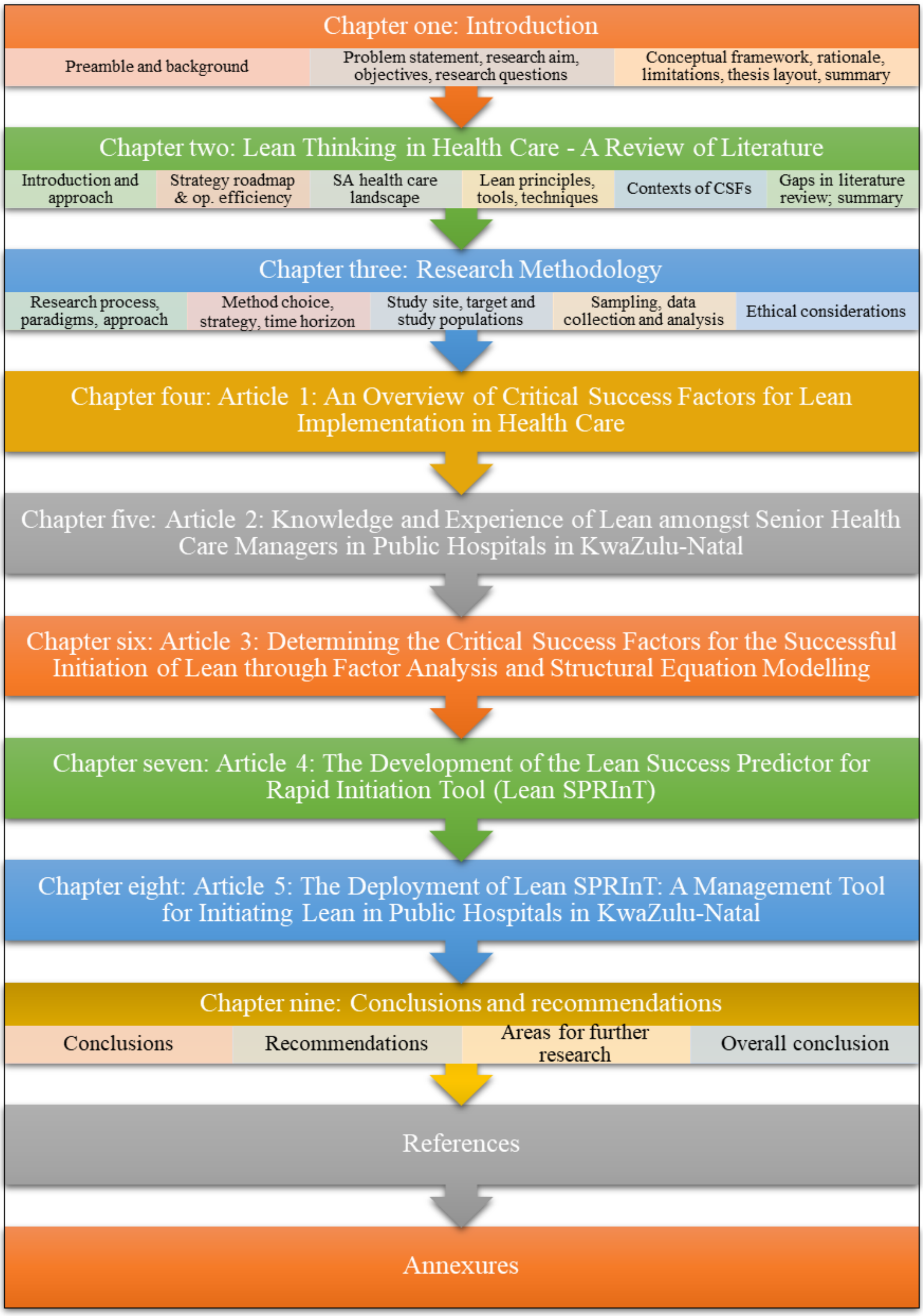


Figure 1.3: Framework of the thesis

Source: Author developed.

1.10.1 Chapter One: Introduction

This chapter provides an introduction and background to, and orientation of the study. The background is followed by the problem statement, research aim, objectives, and questions. The conceptual framework for the research is described, followed by a justification for the study, limitations and delimitations of the study, and a summary of the thesis layout.

1.10.2 Chapter Two: Lean Thinking in Health Care – a Review of Literature

This chapter provides a concise literature review since each article (corresponding to Chapter 4 to Chapter 8) contains its own review of pertinent literature. The chapter includes a brief approach to the literature review, followed by an explanation of the concept of the implementation-intervention gap. The South African health-care landscape is explored, followed by an explanation of the concept of operational efficiency and its barriers. Lean thinking is then described in terms of its principles, concepts, tools and techniques. The worldwide and health-care contexts of critical success factors (CSFs) for Lean are examined. Subsequently, the Lean SPRInT is placed in context in terms of the intervention-implementation gap. The chapter concludes with the gaps in existing literature and how the study addresses these gaps.

1.10.3 Chapter Three: Research Methodology

This chapter focuses on the research paradigm, approach, choices, strategies, and time horizon, in terms of the research onion model. The study site and target and study populations are described, followed by the sampling technique and sample size explanation. Data-collection methods, data quality control, and data analysis are elaborated on. The chapter concludes with a description of the ethical considerations.

The subsequent five chapters correspond in sequence to five original research articles based on this study. The five articles correspond to the research objectives and the conclusion and recommendations chapter of the thesis. All articles follow a sequential, coherent, and structured argument which is aligned with the objectives of the research. The tables and figures within each article are enumerated separately from the rest of the thesis. Each article has its own abstract and bibliography, and is structured according to the requirements of the journal to which it was submitted.

1.10.4 Chapter Four: Article 1: An Overview of Critical Success Factors for Lean Implementation in Health Care

This chapter corresponds to the article entitled "*An Overview of Critical Success Factors for Lean Implementation in Health Care*". This chapter serves to provide a cursory overview of key literature available on CSFs for Lean, both within and external to the health-care sector. It describes the South African context of Health Care Management, Worldwide Context of CSFs for Lean, and the health-care context of CSFs for Lean.

1.10.5 Chapter Five: Article 2: Knowledge and Experience of Lean amongst Senior Health-care Managers in Public Hospitals in KwaZulu-Natal

This chapter corresponds to the journal article entitled "*Knowledge and Experience of Lean amongst Senior Health Care Managers in Selected Public Hospitals in KwaZulu-Natal, South Africa*". The chapter and article correspond to Research Objective 1. They provide the results of an investigation into the baseline level of knowledge and experience of Lean amongst senior health-care managers in public hospitals in KwaZulu-Natal.

1.10.6 Chapter Six: Article 3: Determining the Critical Success Factors for the successful initiation of Lean through Factor Analysis and Structural Equation Modelling

Chapter six correlates with the journal article entitled "*Critical Success Factors for the Successful Initiation of Lean in Public Hospitals in KwaZulu-Natal: A Factor Analysis and Structural Equation Modelling Study*". This chapter and article correspond to Objective 2 and Objective 3 of the study. The objectives were to identify the key variables for the successful initiation of Lean in public hospitals, and to conduct factor analysis and SEM, leading to the identification of CSFs for Lean initiation. Regarded as one of the most important phases of the research, the chapter walks the reader through the reduction of data, using exploratory factor analysis (EFA) to identify latent constructs. The use of confirmatory factor analysis (CFA) to determine the reliability and validity of these factors is then explained. Structural equation modelling (SEM) fit indices were thereafter applied to assess acceptability of the measurement model. The identified CSFs are explored further in relation to existing literature.

1.10.7 Chapter Seven: Article 4: The Development of the Lean Success Predictor for Rapid Initiation Tool (Lean SPRInT)

This chapter consolidates the findings described in Chapter 6 for the development of the Lean SPRInT. The chapter represents the article entitled "*The Lean Success Predictor for Rapid Initiation Tool (Lean SPRInT): A Tool for Initiating Lean in South African Public Hospitals*" and corresponds to Objective 4 of the study. The results of EFA, CFA and SEM which were used to identify the CSFs, each of which consists of elements which itemise the factor, are employed in the genesis of Lean SPRInT. This chapter explores the architecture of Lean SPRInT in terms of the user input interface, the back-end processing of inputs, and the resultant outputs. The utility of Lean SPRInT is described and compared with similar tools which exist in the Lean CSF landscape.

1.10.8 Chapter Eight: Article 5: The Deployment of Lean SPRInT: A Management Tool for initiating Lean in Public Hospitals in KwaZulu-Natal

This chapter corresponds to the conclusion and recommendations of the study; and represents the article entitled "*Lean SPRInT: A management tool for initiating Lean in public hospitals in KwaZulu-Natal*". It proposes a trajectory for the large-scale deployment of the Lean SPRInT in the KwaZulu-Natal Department of Health, with the aim of implementing Lean in health facilities. A 6-step Lean roadmap, incorporating the Lean SPRInT, is described, along with a framework for phasic Lean implementation and the Shingo transformation model for sustainability.

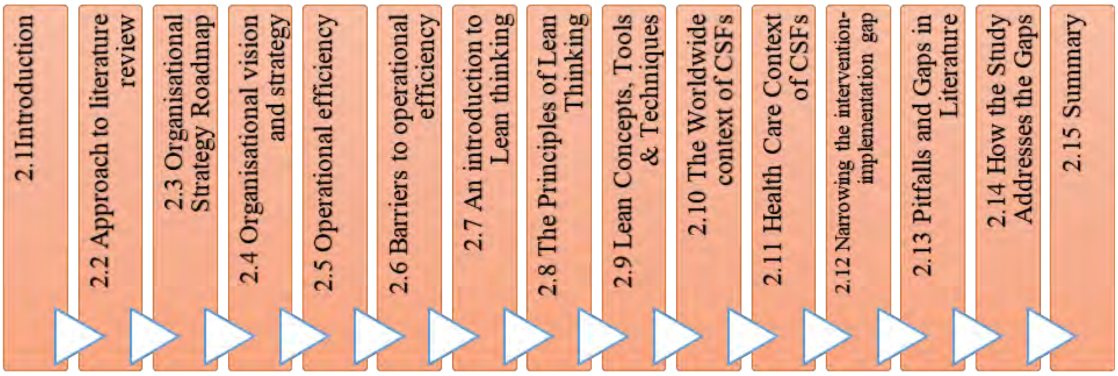
1.10.9 Chapter Nine: Conclusions and Recommendations

This last chapter of the thesis provides overall conclusions and recommendations of the study. The main findings of the study in terms of each research objective are presented in this chapter. Corresponding conclusions and recommendations are also provided. The chapter elucidates the significance of the study and the utility of the results. It provides an indication of possible next steps to realise the true value of the research.

1.11 Summary

This first chapter provided the nature and background of the study. The health-systems challenge in the KZN Department of Health in terms of operational efficiency is outlined as a background. The chapter justifies the study; and highlights that, in order to achieve sustainable recuperation in the delivery of health care with limited resources, efforts must be made toward more efficient health-care management, and doing more with less. A statement of the problem, research aim, objectives, and questions, are provided. A rationale for the study is also explained, along with a conceptual framework, study limitations, and the thesis layout. The next chapter provides a literature review conducted in relation to the study.

2. CHAPTER TWO: LEAN THINKING IN HEALTH CARE - A REVIEW OF LITERATURE



2.1 Introduction

The previous chapter introduced to the reader the research that was conducted, and provided an overview. This chapter concisely examines the literature that was reviewed, since each article (corresponding to Chapter 4 to Chapter 8) contains its own review of pertinent literature. Organisational effectiveness is related to meticulous strategy execution, starting off with a clear vision and goals, as well as an unequivocal road map for implementation of targeted interventions. Barriers to the implementation of these interventions, such as operational inefficiency, contribute to unmet strategic goals, widening the intervention-implementation gap. Identification of factors that correlate to the successful adoption of management approaches, such as Lean, enfeebles the barriers obstructing interventions for the successful realization of strategic goals.

2.2 Approach to the Literature Review

WorldCat®, iCatalogue, and Google Scholar were searched using a combination of the following search strings, amidst several others: “Critical success factors”, “Lean thinking”, “Efficiency in health care”, “Barriers of operational efficiency in health care”, “CSFs for Lean” and “Lean success predictor tools”. References found in journal articles were also used as secondary sources of information, owing to the limited literature available on the research topic during the search. Mainly recent publications with appropriate content in the abstracts were considered, and where definitions and descriptions of concepts originating from original publications were necessary, older publications with the associated content were used.

Systematic reviews and meta-analyses were given priority as literature sources. The literature search was terminated once no new relevant and recent literature was found. The contents of the sources were reviewed systematically and grouped into themes on hand-drawn sketches to create a logical connection and flow amongst the themes. A detailed formative analysis of the sources was conducted, thus producing a consolidated review.

2.3 The Organisational Strategy Road Map: The Intervention-implementation Gap

The framework depicted in Figure 2.1 provides a typical roadmap from organisational strategy to strategic outcomes, guided by organisational vision with strategic goals. South African public health facilities are beset by vastly apparent and abundant barriers, but also by key enablers to the achievement of organisational goals through otherwise well-constructed management interventions.

Figure 2.1: Intervention-implementation gap in the organisational strategy roadmap

Source: Author developed.

Failure to recognise and augment these enablers or "critical success factors" accordingly undermines their potential to narrow the intervention-implementation chasm. This study is anchored in the development of a tool which assesses the status of organisational readiness in terms of the critical success factors for Lean initiation. Such success factors have the potential to narrow the operational efficiency intervention-implementation gap.

In terms of the framework depicted in Figure 2.1, two key components (barriers and critical success factors) of the road map which are related to this study will be explored further, against the backdrop of the South African public health-care system.

2.4 Organisational Vision and Strategy: The South African Health-care Landscape

The strategic goals of health care in South Africa can be summarised by the long-term "Vision 2030" and priorities outlined in the National Developmental Plan, and the National Department of Health's medium-term strategic goals 2014-2019 (Table 2.1) (KZN Department of Health, 2018a). As depicted in Figure 2.2, the execution of the KwaZulu-Natal Department of Health's strategic priorities is conducted through 5 strategic goals which steer 8 administrative subgroups called "programmes" (KZN Department of Health, 2018a).

A significant component of these programmes and goals involves operations and quality management, namely health-systems reforms and strengthening, quality improvement, and financial and information-systems management. However, the answers to how management systems can be overhauled are left wanting.

With the need for overhauling the health-systems delivery platform in KwaZulu-Natal, being the second most populated province in the country, the realization of the strategic priorities in its health transformation agenda has become ever more exigent (KZN Department of Health, 2014, 2018a, 2018b).

Homing in on examples of operations or systems management priorities reflected in the KZN Department of Health's 2018-2019 Annual Performance Plan (Table 2.2) and strategic goals in alignment with macro policies and plans (Table 2.3), it is clear that a considerable portion of the KZN Department of Health priorities and goals are overtly in need of adroit managers, with a sound management approach to be successfully addressed.

Figure 2.2: The 5 strategic goals and 8 programmes of the KZN Department of Health
Source: KZN Department of Health (2018a).

Recently, the South African Department of Health has embarked on a journey of implementing National Health Insurance (NHI) in a drive towards universal health coverage of the population. This is being carried out by creating a functional district health system (DHS) as a platform for primary health care (PHC) re-engineering, strengthening and delivery, as well as reorientation of the health system toward "prevention is better than cure" (Gilson *et al.*, 2014; KZN Department of Health, 2014, 2018a, 2018b; National Department of Health, 2011, 2013, 2014).

Again, the question of how operations or systems-related priorities are tackled in a systematic approach is unanswered, and marginally described. In fact, there is no mention in the above plans of any discernible management approach or system that could be adopted to operationalise the priorities, once again leaving elaborate documents floating without a management tactic to form the backbone of implementation of such.

Table 2.1: National Development Plan Vision 2030, Priorities 2030 and National Department of Health goals 2014-2019

NDP Goals 2030	NDP Priorities 2030	NDoH Strategic Goals 2014- 2019
Average male and female life expectancy at birth increased to 70 years	a. Address the social determinants that affect health and diseases	Prevent disease and reduce its burden, and promote health;
Tuberculosis (TB) prevention and cure progressively improved;		
Maternal, infant and child mortality reduced		
Prevalence of Non-Communicable Diseases reduced	d. Prevent and reduce the disease burden and promote health	
Injury, accidents and violence reduced by 50% from 2010 levels		
Health systems reforms completed	b. Strengthen the health system	Improve health facility planning by implementing norms and standards;
		Improve financial management by improving capacity, contract management, revenue collection and supply chain management reforms;
	c. Improve health information systems	Develop an efficient health management information system for improved decision making;
	h. Improve quality by using evidence	Improve the quality of care by setting and monitoring national norms and standards, improving system for user feedback, increasing safety in health care, and by improving clinical governance
Primary health care teams deployed to provide care to families and communities		Re-engineer primary healthcare by: increas-ing the number of ward based outreach teams, contracting general practitioners, and district specialist teams; and expanding school health services;
Universal health coverage achieved	e. Financing universal healthcare coverage	Make progress towards universal health coverage through the development of the National Health Insurance scheme, and improve the readiness of health facilities for its implementation;
Posts filled with skilled, committed and competent individuals	f. Improve human resources in the health sector g. Review management positions and appointments and strengthen accountability mechanisms	Improve human resources for health by ensuring adequate training and accountability measures.

Source: National Department of Health (2014).

Table 2.2: Examples of KwaZulu-Natal Department of Health Operations or Systems Management-related Priorities 2018-2019

KZN Department of Health Priorities	Key focus areas and interventions (Operations or Systems Management-related items)
Effective budget management	• Ensure cost containment and efficiency measures are in place and strictly adhered to
Improve patient waiting times	• Phased implementation of Centralised Chronic Medicines Dispensing and Distribution
Improve audit outcomes	• Supply Chain, Asset & Contract Management Strategy • Internal control and rigorous implementation & monitoring of the Audit Improvement Plan • Performance Information Improvement Plan • Financial management including Cost Containment Plan • Implement & monitor reviewed decentralised SCM, Financial and Human Resource delegations
Improve HR management	• Strengthen performance management & development
Improve management of performance information	• Implement strategy to improve record management • Rollout of web-based District Health Information System • Improve review and use of data at facility, sub-district & district level and improve the feedback system • Implement performance information management strategy • Implement the approved IT strategy including increasing broadband access at facility level
Manage finalisation and implementation of the integrated Turn-Around Plan	• Finalise the integrated Turn-Around Plan and manage and monitor implementation at all levels • Establish enabling environment for service delivery
Improve access, inequities, quality and efficiencies of District Hospitals	• Finalise the District Hospital Efficiency Study and use findings to inform the District Hospital Rationalisation Plan • Rationalisation including: Review referral systems & pathways; Redefine roles of Family Physicians in District Health System; and Complexing of identified facilities to ensure optimal utilisation of resources • Scale up implementation of National Core Standards • Strengthen Clinical Governance in all facilities
Implement strategy to reduce Medico-legal risks	• Finalise and implement the approved Medico-Legal Strategy & Implementation Plan
Reduce maternal mortality	• Improve safety at caesarean section delivery sites • Improve quality of antenatal, intrapartum and postnatal care
Reduce under 5 mortality	• Strengthen notification of deaths of children in hospital • Improve clinical audits of deaths • Strengthen Paediatric outreach through the District Clinical Specialist Teams
Improve storage medicine capacity at facilities	• Implement Direct Delivery System to facilities • Implement Cross Docking
Prevent medicine stock out, theft and abuse and wastage	• Automation of Expired Medication Alerts to improve stock management

Source: KZN Department of Health (2018a).

Table 2.3: Alignment of KZN Department of Health Strategic Goals with Relevant Macro Plans

KZN Department of Health Strategic Goals	National Development Plan 2030	Medium Term Strategic Framework 2014-2019	Provincial Growth & Development Plan 2030	Sustainable Development Goals 2030
Strategic Goal 1: Strengthen health system effectiveness	**Strategic Goal 6**: Health system reforms complete **Priority b**: Strengthen the health system **Priority c**: Improve health information systems **Strategic Goal 7**: PHC teams deployed to provide care to families & communities	**Sub-Output 3**: Implement the reengineering of PHC **Sub-Output 4**: Reduced health care cost **Sub-Output 6**: Improved health management & leadership **Sub-Output 10**: Efficient health information management system developed and implemented	**Strategic Objective 3.2**: Enhance the health of citizens and healthy communities **Intervention 3.2(a):** Re-engineering of PHC	**Target 7:** Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all
Strategic Goal 2: Reduce and manage the burden of disease	**Strategic Goal 1:** Average male & female life expectancy increased to 70 years **Strategic Goal 2**: TB prevention & cure progressively improved **Strategic Goal 3**: Maternal, infant and child mortality reduced **Strategic Goal 4**: Prevalence of NCD's reduced by 28% **Strategic Goal 5**: Injury, accidents and violence reduced by 50% from 2010 levels **Priority a**: Address the social determinants that affect health and Disease **Priority d**: Prevent and reduce the disease burden and promote health	**Sub-Output 8**: HIV, AIDS & TB prevented & successfully managed **Sub-Output 9**: Maternal, infant & child mortality reduced	**Intervention 3.2.(b):** Scaling up programmes to improve maternal, child and women's health **Intervention 3.2 (c):** Scaling up integrated programmes to expand healthy lifestyle programmes and reduce and manage non-communicable diseases **Intervention 3.2 (d):** Scaling up programmes to reduce incidence & manage prevalence of HIV, AIDS and STIs **Intervention 3.2 (e):** Scaling up programmes to improve TB outcomes **Intervention 3.2 (f):** Implementing programmes to reduce local malaria incidence	**Target 1:** By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births **Target 2:** By 2030, end preventable deaths of new-borns & children under 5 years **Target 3:** By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne and other communicable diseases **Target 4:** By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health **Target 5:** By 2020, halve the number of global deaths and injuries from road traffic accidents **Target 6:** By 2030, ensure universal access to sexual and reproductive healthcare services **Target 8:** By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and pollution **Target 9:** Strengthen the implementation of the World Health Organization Framework Convention on Tobacco Control **Target 10:** Support research and development of vaccines and medicines for communicable and non-communicable diseases
Strategic Goal 3: Universal health coverage	**Strategic Goal 8**: Universal health coverage achieved **Priority e**: Financing universal health care coverage	**Sub-Output 1**: Universal health coverage progressively achieved through NHI **Sub-Output 7**: Improved health facility planning & infrastructure	**Strategic Objective 3.2**: Enhance the health of citizens and healthy communities	**Target 7:** Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all
Strategic Goal 4: Strengthen human resources for health	**Strategic Goal 9**: Posts filled with skilled & competent individuals **Priority f**: Improve human resources in the health sector **Priority g**: Review Management positions and appointments and strengthen accountability	**Sub-Output 5**: Improved human resources for health	**Intervention 3.2 (g):** Improving human resources for health	**Target 11:** Substantially increase health financing and the recruitment, development, training and retention of the health workforce in developing countries, especially in least developed countries and small island' developing states
Strategic Goal 5: Improved quality of health care	**Priority h**: Improve quality by using evidence	**Sub-Output 2**: Improved quality of health care	**Strategic Objective 3.2**: Enhance the health of citizens and healthy communities	**Target 12:** Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks

Source: KZN Department of Health (2018a).

2.5 Operational Efficiency as an Enabler of Organisational Success

The ultimate goal of a health-care system is the health benefit to society in terms of the absence of disease or infirmity, a healthier nation, financial risk protection and a satisfied population (Yip and Hafez, 2015). Several inputs such as human resources, equipment, drugs, and physical infrastructure, impelled by policy instruments, form the recipe for quality of and access to health care, which ultimately leads to the desired health benefit to society (Figure 2.3). Efficiency of a health-care system leads to the achievement of these final outcomes through improved access to and quality of care, with the least amount of resource inputs. Leadership is one of the primary drivers of this venture.

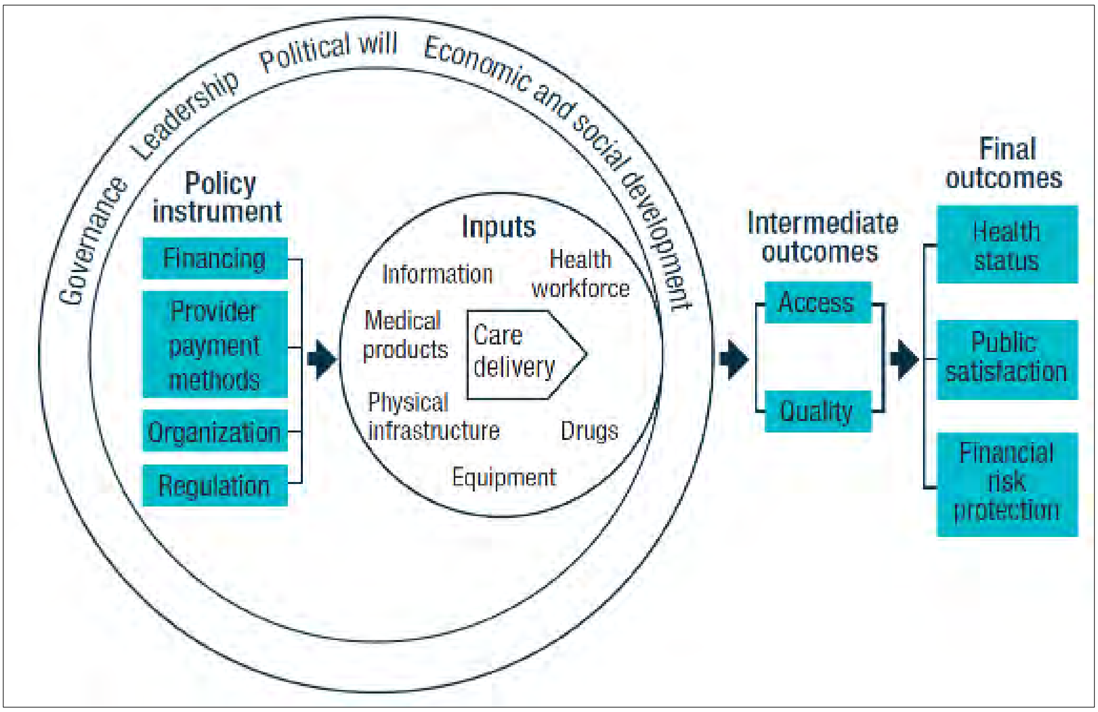


Figure 2.3: A systems framework for health-care efficiency

Source: Yip and Hafez (2015).

In economic and business terms, the concept of "efficiency" is related to the degree of output derived per unit of input of resources with the aim of producing the best value for the customer (Palmer and Torgerson, 1999). Efficiency can be further divided into "allocative efficiency", "technical efficiency", and "productive efficiency" (Palmer and Torgerson, 1999).

In terms of health care, technical efficiency refers to the maximum possible health-care improvement or outcome for the patient that can be derived from the least amount and correct mix of inputs or resources (Palmer and Torgerson, 1999). For example, if a lower dose of a drug can produce the same or better improvement in a disease process than a higher dose of the same drug, then that drug of the lower dose is deemed to be more technically efficient than the drug of the higher dose. Technical efficiency therefore allows for comparison of similar resources or interventions in health care (Palmer and Torgerson, 1999).

Productive efficiency refers to the ‘maximisation of health outcome’ for a relative cost input, or vice versa (Palmer and Torgerson, 1999). Productive efficiency allows for comparison of combinations of various types of resource inputs for a directly comparable outcome. For example, the assessment of risk for a genetic disorder (a directly comparable outcome) may be conducted through a maternal age assessment programme or a biochemical testing (two different combinations or sets of resource inputs) (Palmer and Torgerson, 1999). If the relative cost of risk assessment using the maternal age assessment programme is cheaper than the biochemical testing, the former assessment method is regarded as being more productively efficient.

Allocative efficiency is the allocation of resources such that the benefits to society of optimal health care are maximised from the services and goods offered in the health-care system (Palmer and Torgerson, 1999; Yip and Hafez, 2015). For example, if productively and technically efficient resources are used to manage a disease in the population, but the disease outcomes are more favourable to a particular sector of the population over another (such as people living in a city versus a rural community), then the resources are deemed to have been allocated inefficiently (allocative inefficiency) (Palmer and Torgerson, 1999). The opposite holds true if the resources and disease outcomes are distributed equitably across the population.

Following from the above definitions, operational efficiency relates to the technical and productive efficiency of operations or production activities that occur within a facility. Operational efficiency is often undermined by barriers which ultimately weaken the organisation’s effort to realise its goals.

2.6 Barriers to Operational Efficiency in South African Health-care Facilities

Operational inefficiency derives from the sub-optimal processing of resource inputs in the health-care system. It leads to poor performance of the organisation in terms of measurable health-care metrics and financial reports. Such inefficiency results from, *inter alia*, the mismatch between the genuine need (demand) for health-care services and the supply thereof (over- and under-utilisation); expenditure on items such as drugs, sundries, blood products and laboratory services; inappropriate admissions and prolonged average lengths of stay; deviation from prescribed treatment protocols and medicine formularies; negative incidents and clinical errors and hospital-acquired infections (Madubula, English, Padayachee and Mkhize, 2014).

Describing operational inefficiency in financial terms, the KZN Department of Health incurred an irregular expenditure of R8.96 billion, contingent liability in terms of claims for medical negligence totalling R17.56 billion, and fruitless and wasteful expenditure totalling R8.949 million; as reported in the audited financial statements for the 2017-2018 financial year (KZN Department of Health, 2018b). A large portion of these expenses is the result of operational inefficiency. The external auditor of the KZN Department of Health reported that "*material misstatements identified in the submitted financial statements and annual performance report was due to poor implementation of internal controls, slow response to action plans as well as lack of resources in certain areas*" (KZN Department of Health, 2018b: 261).

In terms of leadership, the auditor added that they "*did not exercise effective oversight and monitoring over the consistent application of policies and procedures, implementation and monitoring of action plans and related internal controls*" (KZN Department of Health, 2018b: 261). This audit finding substantiates an intervention-implementation gap that exists in the province's public health sector.

The intervention-implementation gap is usually perceived as a sign of systems failure. However, some experts argue that it may also herald a policy change, transformation, or contextual aspects of the implementation milieu (Adams-Jack, 2016). Observers of a health system in action tend to associate this gap with inefficiency and failure owing to justifiable beliefs. However, Adams-Jack (2016) claims that there are other relationships between policy vis-à-vis interventions and implementation. Embedded research such as action-research is one way of deepening one's understanding of the intervention-implementation gap (Awoonor-Williams and Appiah-Denkyira, 2017). It is important to critically reflect on implementation gaps to acquire a more profound level of insight into the intricacies of health-system transformation.

Despite this transformation and the developmental trajectory of health services and enthusiasm of government leaders to improving health care in South Africa, social science researchers offer intricate explanations for the "failure of the developmental state" in the country (Seekings, 2015). Seekings (2015) postulates, in simple terms, five concerns that lie behind the mismanagement in public sectors, including health:

a) The high turnover of managers in public hospitals owing to affirmative action policies provided fertile ground for rapid progression up the corporate ladder; as opposed to managers stabilising and focusing on doing their jobs. With a high turnover of public-sector managers, and about one third of them changing jobs each year, this created instability in the journey to improve services in institutions (Naidoo, 2008).
b) Incongruity and contradiction in skills required to perform managerial functions, in the face of employment equity rubrics, provided a game-changing view of productivity in the public sector.
c) Deference and race were more important than competence and skill in managerial roles.
d) A breakdown in work ethic and organisational discipline, with vociferous labour unions and their demands, naturally led to the demise of order and corporate governance in some institutions.
e) Budget mismanagement and extreme resource constraints in the face of increasing demands on the health-care system, and corruption imbroglio amongst certain managers, added more pressure to crumbling institutions.

Rispel (2016:18) associates the failure of health policies in praxis vis-à-vis interventions to deliver a high-performing health-care system in South Africa with three major "fault lines" (Figure 2.4). Rispel (2016:18) posits the existence of a crisis of "ineffective and suboptimal leadership". The researcher contends that the failure to implement key reforms is an example of governance and leadership failure, thus reinforcing the intervention-implementation gap (Rispel, 2016).

- Tolerance of ineptitude and leadership, management and governance failures
- Lack of a fully functional district health system, which is the main vehicle for the delivery of primary health care (PHC)
- Inability or failure to deal decisively with the health workforce crisis

Figure 2.4: Fault lines in the South African health sector
Source: Rispel (2016).

Given this backdrop, a significant shift in management attitude and way of thinking is required to develop a platform which breeds encouragement and improves yield through operational efficiency, and by closing the intervention-implementation gap. This necessitates a recognition of critical success factors for interventions which drive operational efficiency, such as Lean, to help close the intervention-implementation gap.

2.7 An Introduction to Lean thinking: A Novel Solution to Operational Inefficiency

Several efficiency improvement proposals related to operations management in the health-care sector have yet to be fully accepted and adopted. One of these proposals is Lean thinking, a philosophy involving proven operations practices and techniques. Such a philosophy seeks to improve the quality and efficiency of production and service delivery, by creating flow, and eliminating waste in an organisation (Zidel, 2006b). The term "Lean thinking" is an intellectual paradigm underpinning "Lean management", which in turn makes use of "Lean tools" for process improvement and operational tasks. This thesis makes use of the term "Lean" which implies "Lean thinking", unless otherwise stated.

In their 1990 book, *"The Machine that Changed the World"*, Womack, Jones and Roos introduced to the world the concept of Lean (originally coined by John Krafcik in 1988), in order to illustrate the Toyota Production System (TPS), which eliminates waste and does more with less in their production and service processes (Womack and Jones, 1996). One critical aspect of Lean is the empowerment of employees to make changes to their work, thereby improving processes from the floor upwards. On an organisational level, mapping the entire process allows management to augment process steps that are value-adding and relevant to the final product or service for the customer, while systematically eradicating those that fail to add value (Dickson, Singh, Cheung, Wyatt and Nugent, 2009).

2.8 The Principles of Lean Thinking

The principal focus of Lean thinking is on waste reduction, synchronising and addressing process flows with high variability (Casey, 2007). Lean methods are pinned on five precepts (Womack and Jones, 1996; Zidel, 2006a):

- ***Specify value*** by asking oneself what is valuable to the client (the patient);
- ***Identify the value stream*** using a Value Stream Map (VSM);
- ***Facilitate flow in the value stream*** by restructuring process steps and eliminating non-value-adding steps (bottlenecks);
- ***Pull***: The forerunning process down the value-stream (e.g. collect medication from pharmacy) signals when upstream activities (e.g. doctor consultation) can begin, in order to stabilise demand on the system; and
- ***The pursuit of perfection*** through continuous improvement.

2.9 Lean Concepts, Tools and Techniques

Lean uses the following three categories of value stream activities: (1) work that adds value to the client; (2) work that does not add value to the client, but is necessary (type 1 non-value-added work); and (3) work which does not add value to the client and must be eliminated (type 2 non–value-added work or waste, also known as "*muda*" in Japanese) (Zidel, 2006b). Taiichi Ohno, an earlier vice president of Toyota, identified seven types of wastes which Zidel (2006b) has adapted to health care (Table 2.4) (Zidel, 2006b).

Table 2.4: Examples of the Seven Wastes (Type 2 non-value-added work) in Health Care

Delay	Waiting for bed assignments, waiting to be discharged, waiting for treatment, waiting for diagnostic tests, waiting for supplies, waiting for approval, waiting for the doctor, waiting for the nurse
Overprocessing	Excessive paperwork, redundant processes, conducting unnecessary tests, using an IV when oral medication would suffice, multiple bed moves
Inventory	Lab specimens awaiting analysis, emergency department patients awaiting a bed assignment, patients awaiting diagnostic tests, excess supplies kept on hand, dictation awaiting transcription
Transportation	Transporting lab specimens, transporting patients, transporting medication, transporting supplies
Motion	Searching for charts and supplies, delivering medications, nurses caring for patients on different wings
Overproducing	Mixing drugs in anticipation of patient needs
Defects	Medication errors, wrong-site surgery, improper labeling of specimens, multiple sticks for blood draws, injury caused by defective drugs or restraints or lack of restraints

Source: Zidel (2006b).

2.9.1 PDCA cycle

After a dramatic process change (*kaikaku*), one of the key techniques supporting the implementation of Lean that can be used is continuous improvement (*kaizen*) which may be practised using the iterative, 4-step PDCA (*P*lan, *D*o, *C*heck, *A*ct) or PDSA (*P*lan, *D*o, *S*tudy, *A*ct) cycle, also called the Deming or Shewart cycle (Womack and Jones, 1996). The use of the PDCA cycle as a quality improvement technique supports "structured iterative development of change" (Taylor *et al.*, 2014: 291).

The "plan" stage requires assessing a problem and deciding on changes which need to be implemented. The "do" stage reflects implementation of the actions. An assessment of the effect of the actions takes place in the "check" or "study" stage. The "act" stage corresponds to an evaluation of the outcomes, and informs a new PDCA cycle for quality improvement. Figure 2.5 depicts the preliminary steps which lead to the utilization of PDCA cycles. PDCA cycles may be associated with scientific experiment process and action research, since they "promote prediction of the outcome of a test of change and subsequent measurement over time… to assess the impact of an intervention on the process or outcomes of interest. Thus, learning is primarily achieved through interventional experiments designed to test a change" (Taylor *et al.*, 2014: 291). PDCA cycles may be used as part of any process or quality improvement initiative in health-care facilities whilst promoting structured learning.

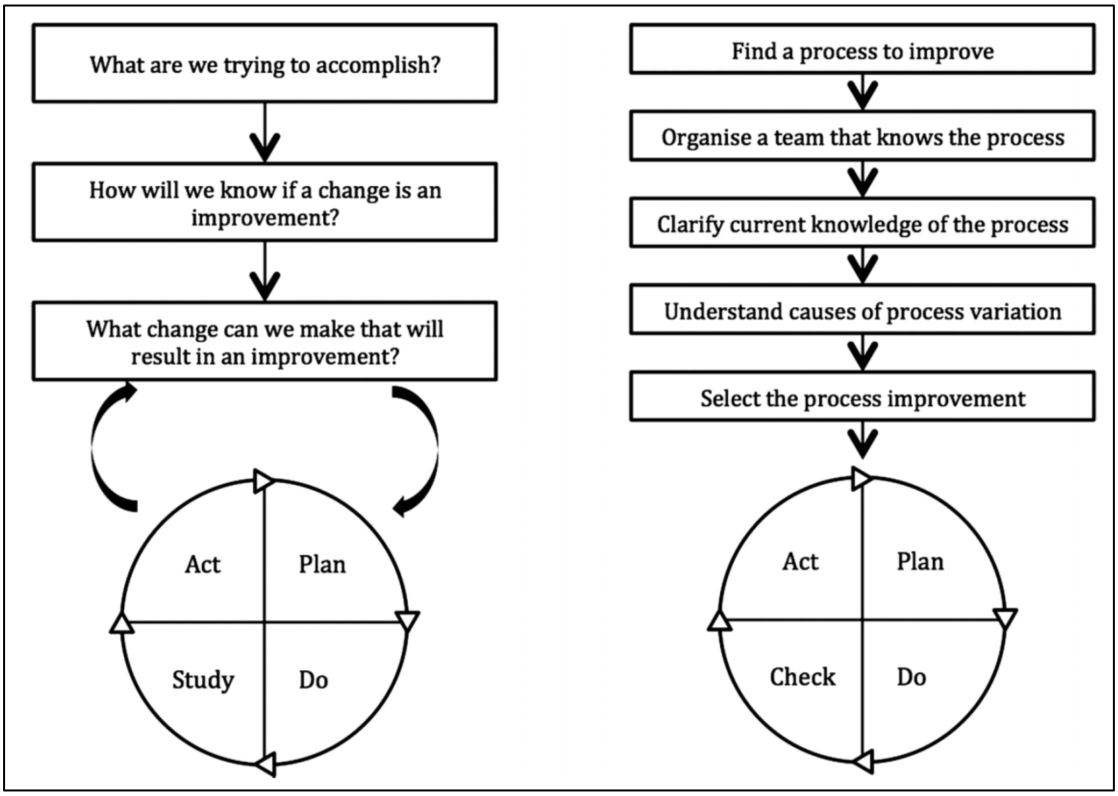


Figure 2.5: Preliminary steps leading to the utilization of PDCA cycles

Source: Taylor *et al.* (2014: 292).

2.9.2 Kaizen teams

PDCA cycles may be facilitated through regular *kaizen* team (or Quality Circle) meetings. The *kaizen* team usually consists of frontline workers from the *Gemba* (actual place where value is being created, such as an OPD) and key role-players who identify problems and plan, implementing and adjusting improvements (Fine, Golden, Hannam and Morra, 2009). *Kaizen* team meetings can help eliminate waste and improve flow, to move the process toward the idealised future state.

2.9.3 Value-stream map

The primary tool of Lean for identifying work activities and waste in the value stream is the current- and future-state value stream map (VSM), an example of which is depicted in Figure 2.7. This is a process flow chart which presents information about speed of value-added work (cycle time), types 1 and 2 non-value-added work (wait time) and the continuity of flow (Casey, 2007). Value-stream mapping corresponds to the second principle of Lean thinking, and it can be used in the "plan" stage of a PDCA cycle.

2.9.4 A3 report

A tool that principally empowers employees in its application is the A3 report, which is the core of Toyota's success in problem-solving. Sobek and Jimmerson (2004) developed the A3 report in 2004 per a National Science Foundation grant (Sobek and Jimmerson, 2004; Visich, Wicks and Zalila, 2010). This tool, which harmonises the PDCA cycle, is the documentation of current and improvement processes on one side of an 11-by-17-inch sheet of paper (Sobek and Jimmerson, 2004). It is used to analyse the way in which a process may be improved in the value stream.

On the left-hand side of the A3 report, the problem background is described, and a root-cause analysis is determined by frontline workers. The right-hand side allows role-players to develop solutions to the problems, and reflects the improvement processes (Sobek and Jimmerson, 2004). The A3 report can be used in health-care institutions together with PDCA cycles to identify problems and their root causes, and to develop action plans to resolve them. It has been shown that hospital employees can initiate the use of A3 reports in their facilities in as little as 3 months, even with low levels of training, making it a very practical and versatile tool for quality improvement in hospitals (Visich *et al.*, 2010: 206).

Table 2.5 describes the content of the A3 report. An example of an A3 report template is depicted in Figure 2.6. By empowering workers, A3 thinking is often the first step toward culture change; this inculcates a spirit of teamwork by fostering work across functional boundaries or "silos" (Grunden, 2009).

Table 2.5: Content of an A3 Report

Left Hand Side	Right Hand Side
1. **Issue**: select a process to observe that has variability in its outcomes, where patient satisfaction could be improved, or costs can be reduced. Ask the question "*What is the Issue through the eyes of the customer/patient?*"	1. **Target Condition**: draw a simple diagram showing a better way to do the work and highlight the improvements with fluffy clouds. Keep the improvement low cost and if possible, create measurable targets for each improvement.
2. **Background**: develop a clear understanding of how the process interacts within the department and the history of the process. Ask *when/where/how often does the problem occur?* and objectively collect data so you can measure the Issue.	2. **Countermeasures**: identify the changes that must be made to the Current Condition in order to achieve the Target Condition. Countermeasures eliminate or convert storm clouds to fluffy clouds.
3. **Current Condition**: create a simple sketch of the current condition by using a set of standard or customized drawing symbols. In the sketch use storm clouds to highlight problems and within the storm cloud state the specific problem. Validate the Current Condition by getting staff input on the accuracy of the sketch.	3. **Implementation Plan**: for each of the countermeasures identify what needs to be done, who will be responsible for getting it done, when it should be completed, and what the expected outcome should be.
4. **Problem Analysis**: list the problems identified in the Current Condition (the storm clouds) and for each problem ask *Why?* five times to determine the root cause of the problem.	4. **Cost/Benefit**: a cost/benefit analysis of the Implementation Plan is necessary in order to justify the process change. Cost is the expense incurred to implement the plan and benefits include both the dollar savings and the improvement in quality.
	5. **Test**: details on how you might test your Implementation Plan prior to full implementation. The Test should determine the effectiveness of the Implementation Plan and it provides an opportunity to make adjustments prior to full implementation.
	6. **Follow-up**: is conducted in order to determine if your Implementation Plan has been accepted and is now the new way to do the work. The Follow-up should include the person responsible, the measure or test to be used, and when the Follow-up will be conducted.

Source: Visich *et al.* (2010: 195-196).

2.9.5 5-Why

The 5-Why analysis tool for root-cause analysis and identifying wastes during *kaizen* team meetings is also part of the Lean toolbox (Zidel, 2006b). The 5-Why analysis can be used in the A3 report for problem solving.

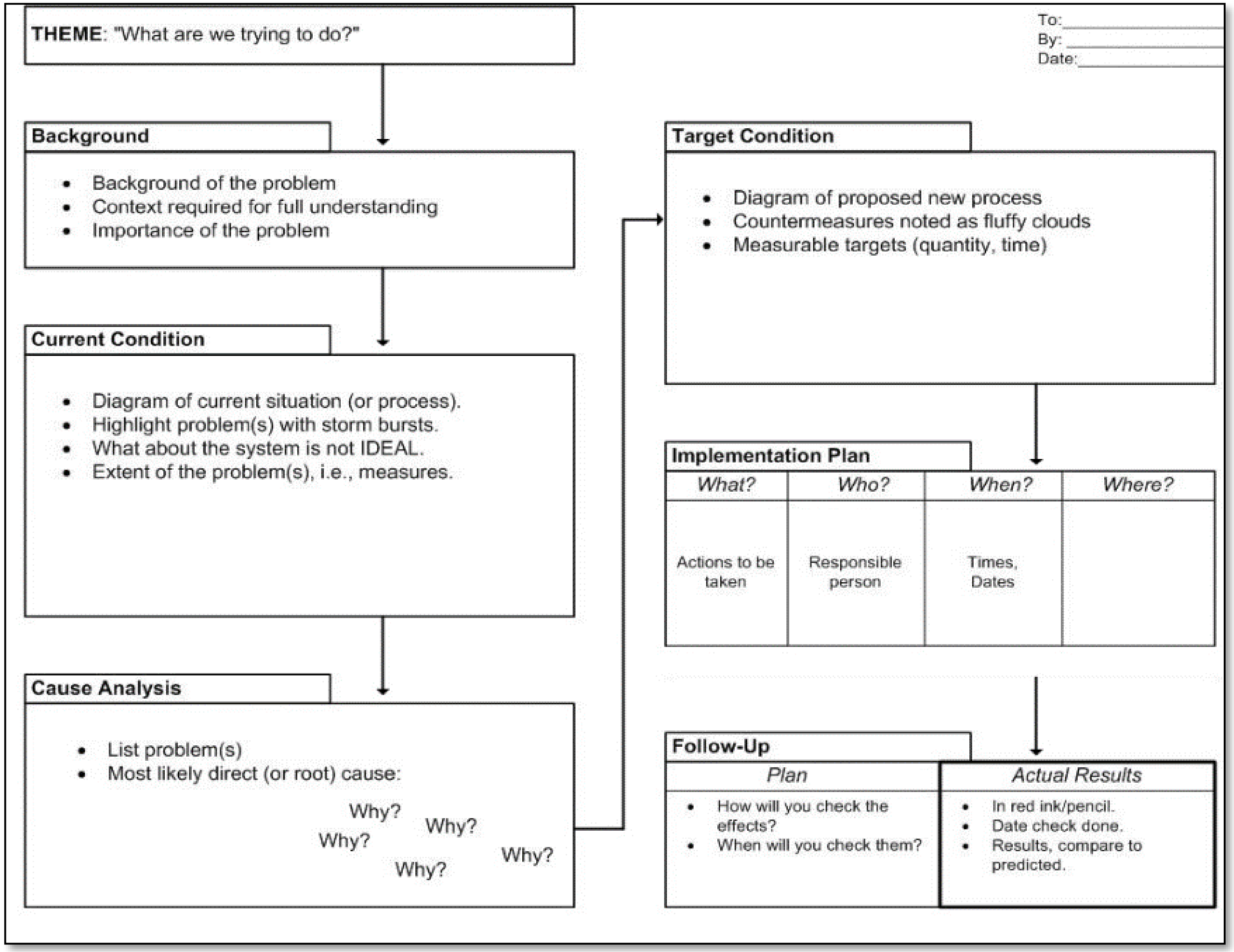


Figure 2.6: Example of an A3 tool template

Source: Author developed.

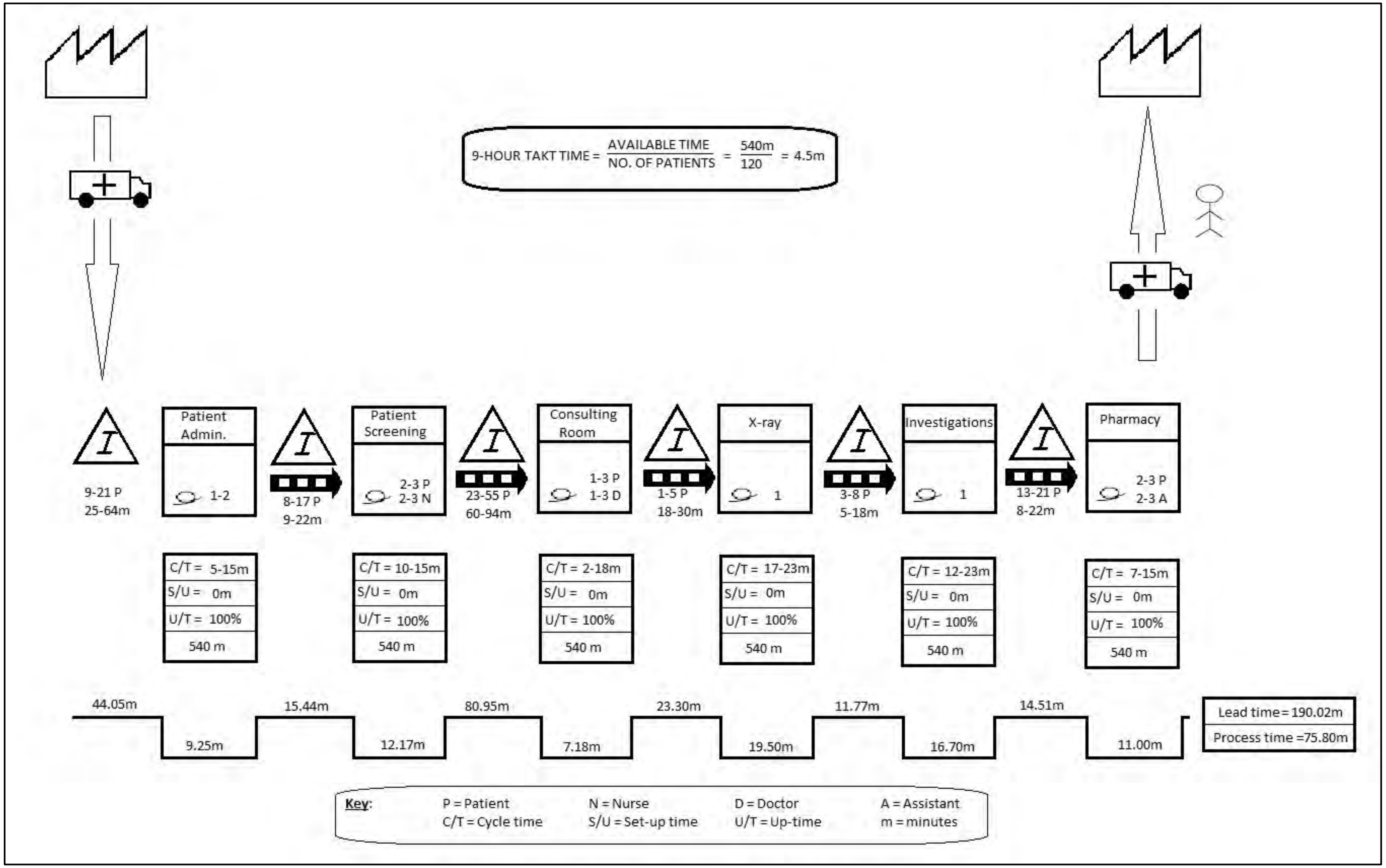


Figure 2.7: Example of a Value Stream Map

Source: Naidoo (2013).

2.9.6 5-S

The 5S (*sort, straighten, scrub, standardize,* and *sustain*) technique, as shown in Figure 2.8, helps with housekeeping, standardization and systemization of work (Zidel, 2006b). For 5S to be successfully implemented, it is recommended that a 5S quality-improvement team be established in hospitals (Bangladesh Ministry of Health and Family Welfare, 2015). This technique can be used in various parts of the hospital, for example (Bangladesh Ministry of Health and Family Welfare, 2015):

- Sort: Segregation of health-care related waste, separation of different laundry items prior to washing or sluicing, sorting of inventory, and for stock management, and sorting and archiving of medical records;
- Set in order: neatening and setting emergency rooms in order, setting emergency or resuscitation trolleys, setting medication in pharmacies, setting laboratories;
- Shine: maintaining cleanliness and infection control throughout the hospital, neatening desktops and work benches, cleaning bathrooms, implementing periodic cleaning schedules;
- Standardise: developing standards for the first three S's, updating monitoring and evaluation checklists and audit tools across the hospital, use of colour coding and other visual systems; and
- Sustain: maintaining self-discipline, orientation of all hospital staff, and regular meetings and feedback.

Figure 2.8: The 5S technique

Source: Way and Way (2018).

2.10 The Worldwide Context of Critical Success Factors for Lean

Critical success factors can be defined as "*the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization*" (Rockart, 1979: 85). Research results have shown the implementation of Lean with and without success, indicating that CSFs for its initiation have to be recognised (Kundu and Manohar, 2012). Several studies, mainly in the manufacturing industry, which recognise the CSFs for Lean, have been conducted in recent years (Table 2.6).

2.11 The Health-care Context of Critical Success Factors for Lean

In the health sector, there is a paucity of studies, especially in South Africa, which uncover CSFs for Lean initiation. The barriers and challenges to the implementation of Lean in the health sector have merely been described by some researchers, but the converse does not necessarily translate into CSFs. Some Lean implementation challenges in the health sector include: variability of processes and patient flow; a lack of understanding of Lean; poor communication and leadership; difficulty in defining waste and difficulty in defining value from patient's perspective (Faull and Booysen, 2007; Grove, Meredith, Anjelis and Neailey, 2010; Naidoo, 2013).

It is further described that empirical literature to "evidence *how* Lean implementation is operationalized in healthcare besides a few isolated case studies that often describe a successful, but isolated project" is deficient (Burgess and Radnor, 2013: 25). However, it has been discovered that there are prominent parallels in the application of Lean in the US (Bohmer and Ferlins, 2006), Australia (Ben-Tovim *et al.*, 2007) and the UK (Bowerman and Fillingham, 2007). The parallels drawn from the application of Lean include: introduction of Lean from a crisis standpoint; commitment of leadership and employees to organisational change; the scrupulous application of Lean tools and techniques such as *kaizen* events; systematic approaches to solving problems, and training of employees on Lean. Some factors indicating Lean implementation alacrity such as adopting a systems view, perception of patients, information utilization, and employee engagement, are also mentioned as crucial to Lean implementation preparation (Radnor, 2011).

Table 2.6: Research Landscape showing Identified Critical Success Factors

Context and researchers	Critical success factors (extracted from literature review)
CSFs relevant to measuring the degree of success of lean implementation in Information Technology support services (Kundu & Manohar, 2012)	Management leadership; Management support; Top management commitment; Organizational culture; Communication; Training and skill building; Financial Capability; Measurement framework
Implementation of Lean Manufacturing within SMEs (P. Achanga, Shehab, Roy, & Nelder, 2006)	Leadership and Management, Financial Capability, Skills and Expertise and Organizational Culture
Enablers and inhibitors during the implementation of Lean in a Mexican Public service organization (Sua´rez-Barraza & Ramis-Pujol, 2010)	Commitment to and wish for improvement; Clear resolve to improve; Focus on the simple and practical; Active leadership Outcome or stakeholder-oriented service; Holistic and transversal thinking; Establishing a system for measuring service process performance; Effective implementation of best Human Resource Management practices
Success factors identified during two Lean implementation projects within the same company: a global manufacturer of food processing machines and equipment (Scherrer-Rathje, Boyle, & Deflorin, 2009)	Management commitment to, and involvement in, the lean effort; Employee autonomy to make decisions regarding business process changes; Information transparency of Lean goals Evidence of initial performance improvements and long-term sustainability of Lean efforts
A secondary review of research literature of key factors of success in the management of the Synchronized Production System (SPS) implementation process (Skrudupaite & Jucevicius, 2011)	Business plan and vision; top-management support (including funding); project management (including project champion and teamwork and composition); change management, organizational culture; effective communication, education and training, knowledge transfer, knowledge management (including skills and expertise); organizational structure; monitoring and evaluation of performance: performance measurements
Critical success factors within SMEs implementing lean (Kumar, Antony, & Douglas, 2009)	Management involvement and commitment; Communication; Link quality improvement to employee; Culture change; Education and training; Link quality improvement to customer; Project selection; Link quality improvement to business; Link quality improvement to supplier; Project management skill; Organization infrastructure; Vision and plan; Information Technology and innovation.
Ten critical success factors for software industries from a pilot study (Antony & Fergusson, 2004)	Leadership engagement and uncompromising commitment of top management, supporting OI, cultural change, Lean training, linking Lean to business strategy, accountability, customer involvement, understanding of Lean methodology, project management, project prioritization, and selection
Four essentials for successful implementation of a Lean programme (Mefford, 2009)	Belief in the new program that it will work; Commitment for implementing it from managers; Involvement of the whole organization – employees, resources; Patience and long-term view for the results

Source: (Achanga, Shehab, Roy and Nelder, 2006; Antony and Fergusson, 2004; Kumar, Antony and Douglas, 2009; Kundu and Manohar, 2012; Mefford, 2009; Scherrer-Rathje, Boyle and Deflorin, 2009; Skrudupaite and Jucevicius, 2011; Sua´rez-Barraza and Ramis-Pujol, 2010).

In a prominent systematic review of 33 articles on Business Source Premier, Web of Science and PubMed, dating from January 1998 to February 2008, four different change mechanisms were described for the encouraging results generated through Lean. Outlined in all of the reviewed articles were: "understanding processes; planning and organising for effectiveness and efficiency; increasing awareness and process reliability"; and collaborating amongst staff to systematically solve problems (Mazzocato, Savage, Brommels, Aronsson and Thor, 2010).

A study in the Gauteng province in South Africa investigated the success of Lean in public hospitals. The gist of such could not be described more aptly as follows:

> *"The research exposed Lean as appropriate in multifaceted knowledge work environment comparable to assembly-line manufacturing. Executed decorously, Lean transmutes the manner organizations behave and initiate a voracious pursuit for improvement. The paper delineates Lean philosophies as deliberate, signifying the vital vibrancy of Lean. The fundamentals isolated were, postures on continuous improvement, value creation, and unity of purpose, reverence for employees, visual tracking, and malleable procedure… The mechanisms encompass a structure or exemplar for gauging, assessing, analyzing and improving the hospitals"* (Kruger, 2014: 79).

2.12 Narrowing the Intervention-implementation Gap

The chasm between knowledge and action in health care can be categorised into "know-do" and "do-know" gaps, and the adaption of such knowledge ("know") and action ("do") to the local situation. Closing this gap could improve efficiency in health care (Thamlikitkul, 2006). Health knowledge is generated through research evidence ("know-do") and during implementation ("do-know"). Its use in the formulation of policy interventions is futile if the intervention-implementation gap is widened with barriers. Narrowing this gap requires a management approach to improve operational efficiency, so that policy interventions can be successfully implemented.

According to the World Health Organisation (2007a:1), "*[g]ood leadership and management are about providing direction to, and gaining commitment from, partners and staff, facilitating change and achieving better health services through efficient, creative and responsible deployment of people and other health resources*" (Doherty, 2013: 7; World Health Organisation, 2007a: 1). Doherty (2013:9-10) cites Lipsky's (1980) theory of "street-level bureaucrats", who, in health facilities, are the front-line workers, such as doctors and nurses with direct patient and family contact make decisions on a daily basis at the 'coalface' on resource deployment and health-care options, which affect the performance of the institution (Doherty, 2013: 9-10). The degree of clinical leadership demonstrated in these "street-level bureaucrats" inevitably influences the operational efficiency to which the organisation performs.

It is further argued that unified efforts of clinical and non-clinical services in health-care facilities, decentralised clinical and managerial decision-making, and culture transformation, is more likely to lead to better outcomes (Doherty, 2013). Lean, as a management philosophy, fosters these characteristics. If effectively inculcated in and practised by leaders at all levels within health-care institutions, Lean is likely to lead to improvement in operational efficiency, thus narrowing the strategy intervention-implementation gap depicted in Figure 2.1. The question, however, related to initiating Lean in health-care facilities is "*how does one predict the success of Lean implementation?*" This study answers this question by identifying the critical success factors of Lean, and proposing a tool for predicting success of Lean implementation.

2.13 Pitfalls and Gaps in Existing and Reviewed Literature

Apart from the elaborate descriptions of the challenges and success factors for Lean implementation, one of the key gaps elucidated in the above literature review includes a dearth of studies in the health-care sector, especially in South Africa. Of the reviewed literature, none proposed any recommendations for the application or identification of critical success factors for Lean in the South African health-care sector. No tools were identified from the reviewed literature that proposed either the initiation of Lean or assessing the readiness of health-care institutions for the roll-out thereof. Success factors are merely described and analysed; however, none of the studies proposed an initiation tool for Lean in health-care institutions, let alone in Africa.

Another important finding is the vast focus on success factors in non-health-care organisations, possibly because Lean originated in the manufacturing sector. No literature describing the knowledge and experience of health-care workers of Lean in South Africa could be found.

A landmark structure literature review on operations management elements in 177 research papers published between 2000 and 2015 was carried out, involving service operations strategy, quality, performance, scheduling, and frontline employees (Jha, Sahay and Charan, 2016). The review showed that a significant share of empirical studies was conducted in developed nations (Jha *et al.*, 2016). Accordingly, the unique challenges experienced in developing and underdeveloped nations compared with the developed nations necessitate more health-care operations-management research.

Green and Glasgow (2006), cited in Awoonor-Williams and Appiah-Denkyira (2017): "…*if we want more evidence-based practice we need more practice-based evidence*". This supports the need for research addressing literature gaps in the field of Lean implementation.

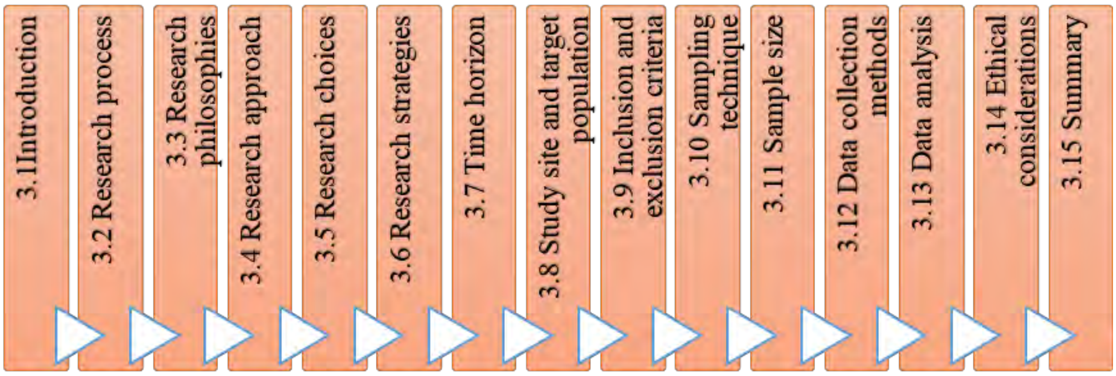
2.14 How the Study Addresses Pitfalls and Gaps of Past Research

The study first aimed to uncover the knowledge and experience of Lean; and to identify Lean success variables from senior health-care managers in KwaZulu-Natal, South Africa. This knowledge currently does not exist. Unravelling such information enabled the researcher to conduct a factor analysis and structural equation modelling (SEM) to detect the CSFs for Lean in South African public hospitals. There is apparently no evidence to show that such factors have been previously isolated in the South African health-care sector, let alone in Africa. The researcher was then able to fill the void existent in the systematic Lean implementation toolbox in South Africa by developing a robust tool for success prediction of the rapid initiation of Lean (Lean SPRInT) which could be adopted by the Department of Health for scaling up Lean.

2.15 Summary

In this second chapter, Lean was introduced to the reader as a fast-growing management approach which uses tools and techniques that are easily adaptable and suitable for application in public hospitals. The chapter included an explanation of the concept of the implementation-intervention gap. The South African health-care landscape was explored, followed by an explanation of the concept of operational efficiency and its barriers. Lean thinking was then described in terms of its principles, concepts, tools, and techniques. The worldwide and health-care contexts of CSFs for Lean were examined. Subsequently, the Lean SPRInT was placed in context in terms of the intervention-implementation gap. The chapter concluded with the gaps in existing literature and how the study addresses these gaps. The next chapter explains the research methods which were employed in the study.

3. CHAPTER THREE: RESEARCH METHODOLOGY



3.1 Introduction

The previous chapter examined the existing literature pertaining to this research. In this chapter, the research design and methods employed in this study are described. At the outset, the research process followed in this study is outlined. The "research onion" model (Figure 3.1), described by Saunders, Lewis and Thornhill (2012:128), is then utilised as a framework for providing a detailed account of research methodology in terms of research paradigms, research approaches, research strategies, research choices, time horizon, and data-collection techniques and procedures. With the aim of adopting the most optimal research methods to produce valid and reliable results in addressing the research objectives, the researcher initially undertook to analyse the concepts depicted in the outer layers of the research onion. Such an analysis ultimately provided the boundaries as well as the context within which to develop and apply data-collection techniques and tools. Selection of the most appropriate research strategies, choices of time horizon and data-collection techniques ultimately have implications for the study's results (Saunders, Lewis and Thornhill, 2012).

Using the research-onion model (Figure 3.1) as a framework, this chapter presents an explanation of each of the elements in the various layers of the onion, along with its advantages and disadvantages, and the most appropriate choice adopted in this study. Knowledge of the elements of the outer layers of the onion enabled the researcher to align the choice of research methods with the objectives of the study, providing a coherent research design.

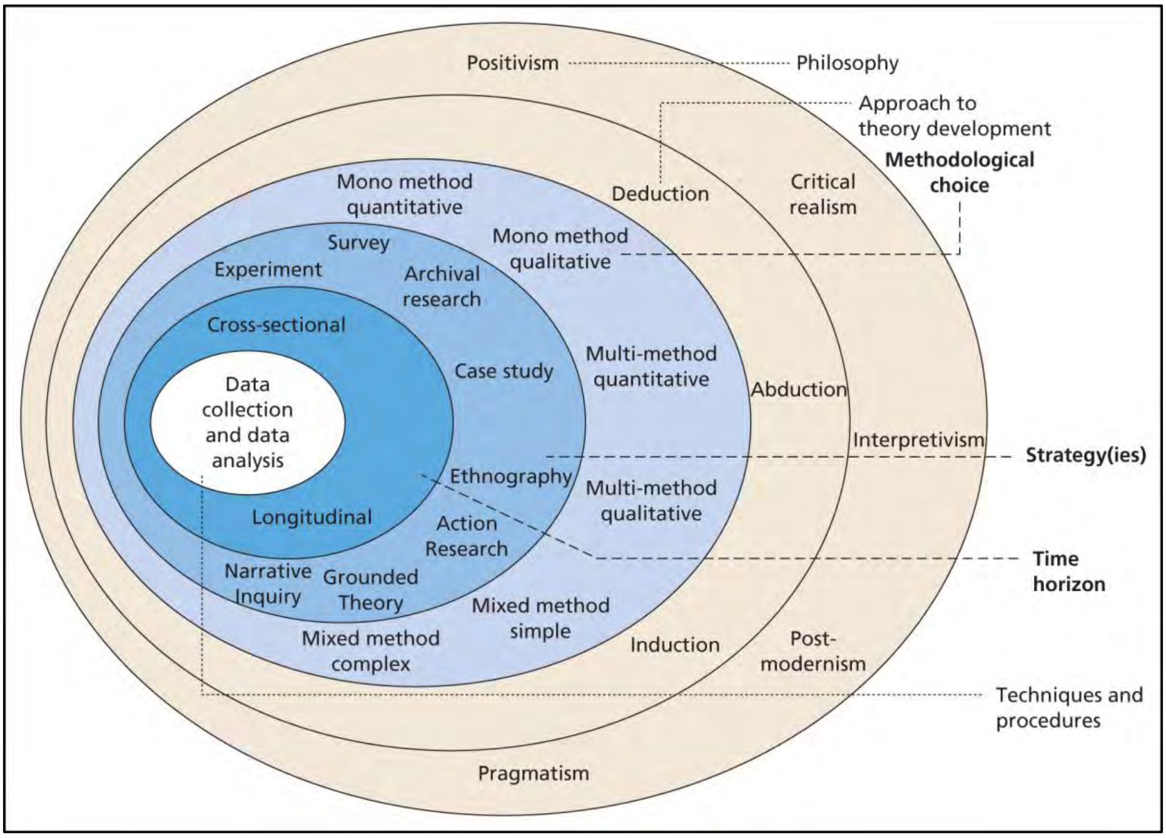


Figure 3.1: The research onion model

Source: Saunders *et al.* (2012).

3.2 Research Process

Research can be defined, in simple terms, as "a systematic search for information, a process of inquiry" (Graziano and Raulin, 2004: 31). Similarly, research is seen as a "process by which individuals attempt to learn things in a systemic way in order to increase their knowledge" (Saunders, Lewis and Thornhill, 2009: 5). Research design is use of research techniques, tools, and instruments to query a particular problem or question (Maylor & Blackmon, 2005). The research process is a sequence of steps that must be carried to undertake research (Gerrish and Lacey, 2010: 13). This systematic process of enquiry, which aims at addressing a research question or more than one such question, assumes a stepwise approach to fulfilling the objectives of a research study. Gerrish and Lacey (2010:14) simplify this approach as nine research steps, which the researcher has adopted, outlining the relevance of such steps in terms of this study (Figure 3.2).

The research process was observed after an analysis of the research onion layers, to decide the research design route on which to embark. Research design is defined as a "plan and the procedure for research that spans the decisions from broad assumptions to detailed methods of data collection and analysis" (Creswell, 2009: 4). Research design, in terms of the methods employed in the investigation, is influenced by the research philosophy paradigm, the outermost layer of the research onion.

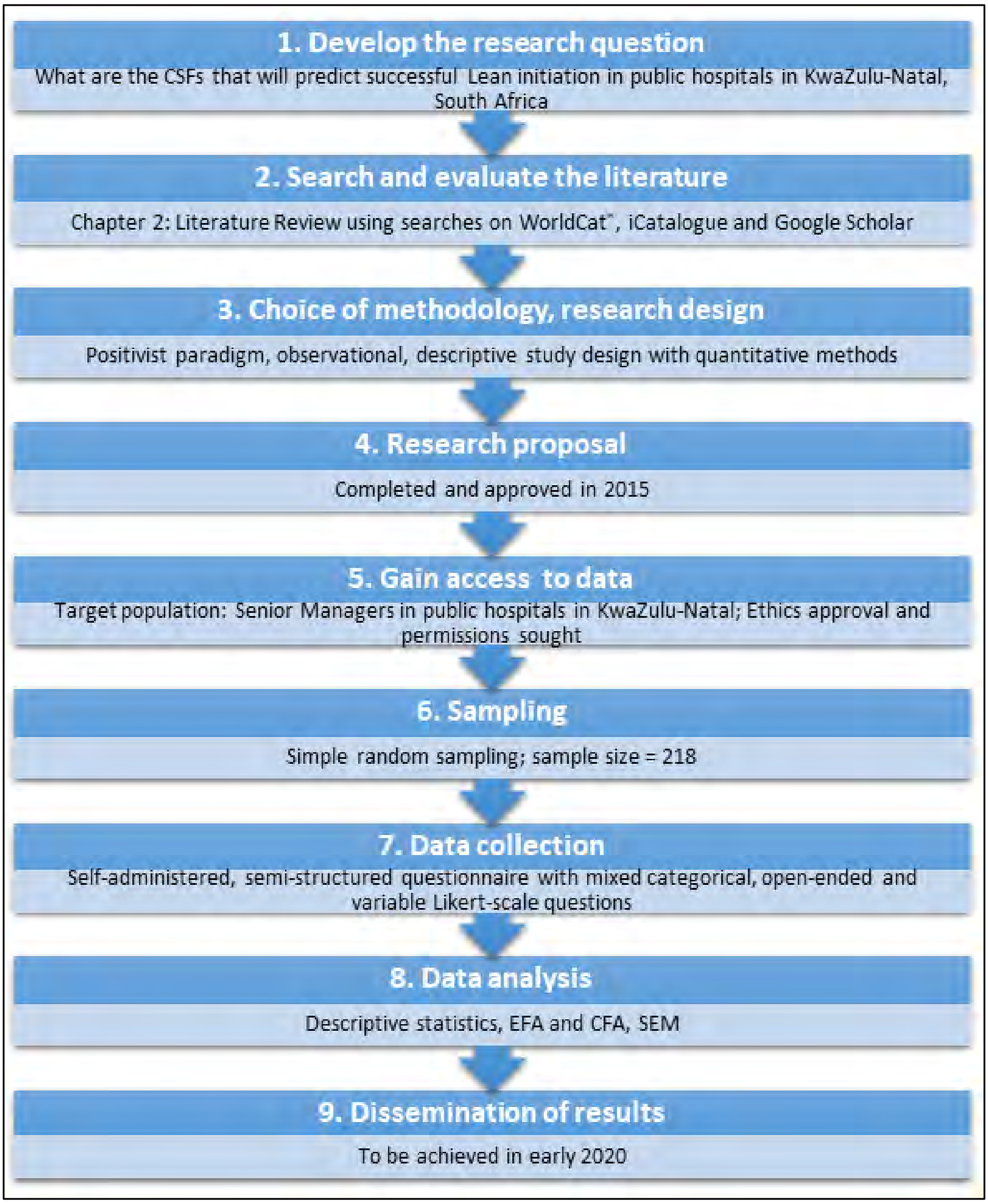


Figure 3.2: The research process used in this study

Source: Author developed.

3.3 Research Philosophies or Paradigms

As the first layer of the onion, a research philosophy or paradigm may be seen as a "lay down of fundamental viewpoints about the natural world of realism and how it might be identified" (Guba and Lincoln, 1994: 108). Research philosophy demarcates the nature of the research by definition of its ontology (the nature of science or reality), epistemology (the relationship between the researcher and the object of research and how he or she reports the sources of knowledge or facts), and axiology (a reflection of the values and beliefs of the researcher) (Adebesin, Kotze and Gelderblom, 2011: 5; Melnikovas, 2018: 33).

3.3.1 Positivism

It has been proposed that positivism as a research paradigm could be considered in terms of the "ontological doctrine that truth and reality is free and independent of the observer" (Aliyu, Bello, Kasim and Martin, 2014: 81). A positivist researcher assumes a worldview of laws and rules of causation, and conducts investigations with the intention of emphasising impartiality through repeatability, objectivity, and neutrality in research (Aliyu *et al.*, 2014). The research methods used by positivist scholars and researchers typically consist of experiments, quantitative, or confirmatory analyses, and deductive reasoning (Olesen, 2004).

The positivist research paradigm uses deductive reasoning in its knowledge-acquisition process. Deductive reasoning, as opposed to inductive reasoning, is a process used in an investigation whereby "a conceptual and theoretical structure is developed which is then tested by empirical observation" (Hussey and Hussey, 1997: 19). Thus the investigator moves "top down" from general influences or generalizations, to more particular or specific confirmations or conclusions (Aliyu *et al.*, 2015; Trochim and Donnelly, 2006) (Figure 3.). On the other hand, an inductive, "bottom-up" approach, is one in which the investigator develops a theory based on observation of empirical reality. Thus there is no *a priori* conception of variables as opposed to deductive research (Aliyu *et al.*, 2015; Hussey and Hussey, 1997).

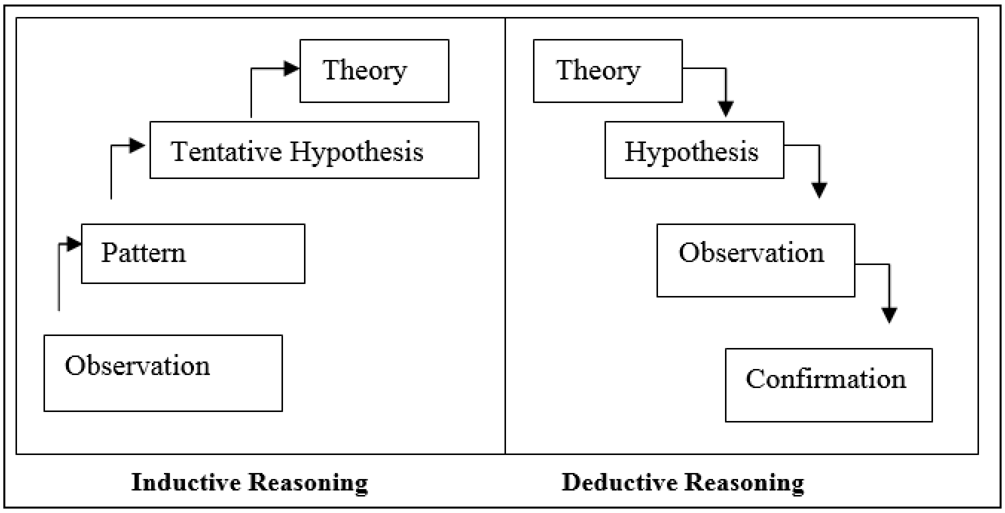


Figure 3.3: Inductive and deductive reasoning

Source: (Aliyu *et al.*, 2015; Trochim and Donnelly, 2006).

3.3.2 Realism

Realism is another philosophical standpoint of researchers, whereby reality exists and is perceived by the researcher through his or her senses, as being the truth in the real world (Saunders *et al.*, 2009; Saunders and Tosey, 2013: 58). Nevertheless, the researcher may still be influenced by his or her own world views or experiences, thus creating the same or different reality from the actual truth. There are two categories of realism which have described in literature: direct realism and critical realism (Saunders *et al.*, 2009; Saunders and Tosey, 2013: 58).

When a researcher perceives through his or her senses whatever is experienced as being the actual reality and frank representation of the reality, this is referred to as direct realism. On the other hand, when the researcher subjectively processes whatever he or she perceives through the senses as being different from the reality, this is referred to as critical realism (Saunders and Tosey, 2013). The implication of critical realism relates to the research-enquiry techniques and procedures which must distinguish the researcher's subjective interpretation of reality from the actual reality (structures lying beneath the researcher's interpretation thereof). Some researchers' approaches to the enquiry, if influenced through critical realism, may affect the validity of the research results.

3.3.3 Interpretivism

Researchers involved in collecting unrestricted insights with a rich content of perceptions, shared values, and experiences of a subject in a social context, tend to adopt an interpretivist philosophical stance (Saunders and Tosey, 2013: 58). Within this paradigm, an inductive, "bottom-up" approach is adopted, in which the researcher develops a theory based on observation of empirical reality, thus there is no *a priori* conception of variables as opposed to deductive research (Aliyu *et al.*, 2015; Hussey and Hussey, 1997). Interpretivism is more likely to be associated with the investigation of social phenomena in dynamic social contexts (Saunders and Tosey, 2013). Therefore, the investigation and its acknowledgement of multiple realities is a characteristic of the interpretivist's research.

Interpretivist researchers are subjective in the research process. Such researchers immerse themselves in the research context, do not remain neutral to the subjects' views, and must describe their influence on the research findings (Adebesin *et al.*, 2011: 310). The interpretivist assumes that discourse is a constituent of subjects being studied, hence the socially-constructed reality must be investigated through social channels such as consciousness or language (Melnikovas, 2018: 35; Myers, 2008).

Interpretivist researchers focus on people rather than objects, thus the research embraces empathy and an understanding of others' social context. The researcher and the human behaviour of the subjects are typically integral to the research. The data-collection tools and techniques employed are aimed at gathering in-depth, rich, qualitative data from small samples (Saunders and Tosey, 2013: 58). This research paradigm affords utility to the social sciences.

3.3.4 Pragmatism

This research philosophy considers the belief that there may be multiple viewpoints and realities in the research precinct (Saunders and Tosey, 2013: 58). Consequently, pragmatists tend to utilise multiple data-collection tools and techniques to decipher the possibility of multiple realities. Pragmatist researchers focus heavily on the relevance, credibility, and reliability of the design of the research (Al Zefeiti and Mohamad, 2015: 3). They assume that the epistemological, ontological, and axiological stance is determined by the research question. Therefore the strength of the research is dependent on the degree to which the research tools and processes are able to reflect reality, and address the research question(s) and objective(s) (Al Zefeiti and Mohamad, 2015: 3). Unlike realism, which focuses on the direct or critical reality, pragmatism relies on a mixture of approaches, techniques, tools, and analyses to address research questions. Triangulation of methods to support the reality is characteristic of pragmatist researchers. Researchers typically involve themselves in employing the best research methods for addressing research problems, usually by engaging a combination of qualitative and quantitative techniques and analyses to produce reliable and more realistic outcomes (Johnson and Onwuegbuzie, 2004).

3.3.5 Comparing the research philosophies

In summarising the four research philosophies, one can appreciate their distinct characteristics in terms of their epistemology, ontology, axiology, and data-collection methods. Table 3.1 provides a brief comparison of the four research philosophies.

3.3.6 Research philosophy for this study

This study is centred on a positivist research philosophy. A positivist paradigm was adopted because explicit procedures were required to establish procedural objectivity and sound statistical relationships amongst variables, in order to determine critical success factors for Lean, and to produce a credible Lean success predictor tool. It is important to highlight that positivism assumes controllability and predictability of the future, hence the repeatability and reliability of the research outcomes (in this case, the knowledge and perceptions of Lean by senior managers; and the development of the Lean success predictor tool) by the extrapolation of research findings is of paramount importance.

Objectivity and appropriate research tools and techniques in this study are important in determining the critical success factors for Lean, and in developing a predictor tool for the successful initiation of Lean in public hospitals. The researcher must extract himself from the beliefs and perceptions of social actors in the research environment in order to uncover true knowledge. A large enough sample size and the employment of quantitative methods is required to maximise the integrity and validity of the research results.

Table 3.1: Comparison of the Research Philosophies

Research philosophies	Positivism	Realism	Interpretivism	Pragmatism
Epistemology: the relationship between the researcher and the object of research and how he/she reports the sources of knowledge or facts	Only observable objects can provide reliable data and facts. Emphasis is on cause, effect, impact and law to make generalisations. It reduces constructs to its simplest elements.	Observable objects give reliable data and facts. Inadequate data implies imprecisions in feelings (direct realism), while objects that provide feelings which are vulnerable to misconception (critical realism). Emphasis is on discussions within the framework	Centres on perceptual meanings and social constructs. Emphasis is on the information surrounding the situation, the background of the information, perceptual values and rationale behind the actions.	Any or combinations of observable constructs and perceptual values lead to acceptable knowledge, dependent on the nature of research questions. Emphasis is on applied research, adopting multiple techniques of data collection and interpretation of results.
Ontology: the investigator's perception of what institutes the nature of science or reality.	Objects are seen as external and possess a reality that is different from that of the investigator.	Objective in nature, its existence is completely different from the thoughts, and beliefs of social actors (direct realist), its interpretation comes from social circumstances (critical realist)	These are social constructs built in from social interactions and actions of others. Subjective and variation is inevitable	Emphasis is on better ways to provide answers (solutions) to the research questions (problem). The decision on the suitable techniques is dependent on research questions
Axiology: a reflection of the values and beliefs of the researcher	The investigation is carried out in a value-free way; the investigator is alienated and upholds an objective mind set.	Investigation is value loaded; the investigator's point of view is subjective based on the social experiences and background which often impact on the outcomes of the study.	Investigation is value assured; the investigator is part of the investigation, not possible to be indifferent and makes the whole exercise sometimes subjective.	Values take a significant place in interpretation of results; the investigator adopts both objective and subjective perspectives.
Common data collection methods	Very organised, takes big samples, measurements are quantitative and permitted to use qualitative when necessary.	Techniques adopted must be in alignment with the research questions, qualitative or quantitative.	Takes small samples with deeper examinations, more qualitative.	Takes mixed or multiple approaches, that is, qualitative and quantitative approaches.

Source: Adapted from Saunders *et al.* (2009: 119) and Atiku (2014: 118).

3.4 Research Approaches

The second layer of Saunders *et al.*'s (2016) research onion is the research approach. Two distinct research approaches are examined: the deductive and the inductive approach. The researcher acknowledges the importance of recognising the characteristics of these research approaches in order to adopt an appropriate approach for this study.

3.4.1 Deductive research approach

This approach to theory development begins with the use of existing literature to identify ideas and theories, which are then tested through the research process (Al Zefeiti and Mohamad, 2015: 3). Research questions or hypotheses are generated after analysing existing theory. Data is thereafter collected and analysed in order to answer the research questions and/or to accept or reject the research hypotheses (Melnikovas, 2018: 34). Accordingly, the deductive approach is used for the testing of an existing theory. Deductive reasoning or logic begins from general rules in literature and moves towards law-like inferences to test a theory (Saunders, Lewis and Thornhill, 2016). The course of moving from existing theory to research questions or hypotheses generation, addressing these, and reverting to theory as part of the scientific enquiry process, is referred to as verification (Maylor and Blackmon, 2005: 150).

The deductive research approach to theory development is rooted in the research philosophy of positivism (Bryman and Bell, 2011). Implicit in this alignment of the research approach with research paradigm is the assumption that, in using the deductive approach, the researcher is objective; extracting him- or herself from the influences of an existing theory, and during the enquiry process.

3.4.2 Inductive research approach

This research approach, in contrast to deductive reasoning, begins with a specific observation, moving towards the development of a theory through the research process of data collection and analyses (Al Zefeiti and Mohamad, 2015; Melnikovas, 2018; Saunders *et al.*, 2016). The inductive approach is often used in research in which little theory exists, thus aiming to develop theory in the research field (Melnikovas, 2018: 34). The investigator develops a theory based on observation of empirical reality, thus there is no *a priori* conception of variables as opposed to deductive research (Aliyu *et al.*, 2015; Hussey and Hussey, 1997). The inductive approach relies on rich qualitative data to analyse for the development of theory, and is rooted predominantly within interpretivist philosophy (Saunders *et al.*, 2016).

A key strength of this research approach is its emphasis on techniques which collect rich, unadulterated data directly from subjects, using a qualitative approach (Thomas, 2006). In contrast to the deductive approach, the inductive approach utilises much smaller sample sizes and tools and techniques for collecting comprehensive, voluminous, in-depth information from subjects (Thomas, 2006). Leaning toward the interpretivist research philosophy, the inductive research approach lends itself to subjectivity in the research process. The researcher's own insights into the phenomenon under investigation influences the interpretation of data, and characterises the ontological perspective of this approach as subjective (Saunders *et al.*, 2009). This could be viewed as a major limitation.

3.4.3 Abductive research approach

Although inductive and deductive approaches are widely used by most researchers, contemporary research is moving towards employing an abductive research approach (Kuosa, 2011). Abductive reasoning has been defined as "a form of inference that has close affinities to (or even is the same as) explanation-seeking why-questions" (Paavola, Hakkarainen and Sintonen, 2006: 2). Similar to the inductive approach, this approach is used where there is a paucity of knowledge on the subject under investigation. The abductive approach is also used when a "best guess" is made on existing evidence or "weak signals as the first symptoms of change", thus moving towards theory development (Melnikovas, 2018: 41). The trigger of an abductive approach is usually the identification of a new and unanticipated fact, which results in the researcher swaying between the deductive and inductive approach in search of ultimate reasoning (Melnikovas, 2018: 34).

3.4.4 Research approach used in this study

Considering the characteristics of the research approaches which have been described above, the researcher chose to adopt the deductive approach, which is also aligned with the positivist research philosophy. The aim and objectives of this study warrant a deductive approach. Existing literature would have to be analysed before the researcher could proceed with the research process for identifying the critical success factors for Lean initiation in public hospitals.

The verification of critical success factors for Lean initiation, as described in studies conducted within and outside the health-care sector, involves moving from existing theory to data collection and analyses, the recognition of senior managers' knowledge and experience with Lean, and identifying the critical success factors for Lean initiation. A Lean success predictor tool would have to be developed, and reflecting on these results in terms of existing literature would be required (Maylor and Blackmon, 2005). In the Lean body of knowledge, there is sufficient theory from which to draw inferences and to develop research questions. Thereafter, data collection and analyses would ensue, in order to determine the critical success factors for Lean initiation. Accordingly, the inductive and abductive approaches are inappropriate to this study.

3.5 Research Methodological Choices

The next layer in Saunders *et al.*'s (2016) research onion is research methodological choices. These choices are the various techniques available for data-collection and data-analysis procedures. The research choices are influenced by whether the researcher intends using qualitative or quantitative methods, or both (Melnikovas, 2018). Figure 3.4 depicts the various research methodological choices available.

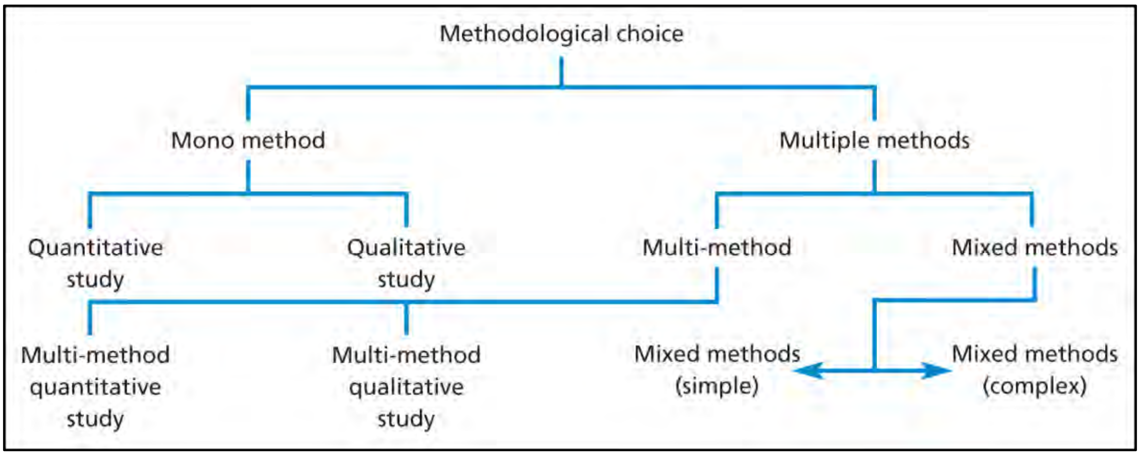


Figure 3.4: Research methodological choices

Source: Saunders *et al.* (2016: 152).

Saunders *et al.* (2009:151) highlight the common choices made by researchers, namely "mono method, multiple methods and mixed methods research".

3.5.1 Mono method

Mono method is used when either the quantitative or qualitative data-collection and analysis technique is required (Melnikovas, 2018). The mono method subjects data to statistical analysis, and numerical results are presented (Saunders *et al.*, 2009: 151). Using either a quantitative or qualitative mono method in research is usually not appropriate for addressing complex research problems. Such problems generally require a combination of qualitative and quantitative methods for producing credible results. The "creation of inventive methods" should capture a problem and discover hidden facets in research phenomena (Al Zefeiti and Mohamad, 2015; Todd, 1979).

3.5.2 Multiple methods

Multiple methods are further classified into multi-methods (quantitative or qualitative) and mixed methods (simple or complex). Two or more data-collection and parallel-analysis techniques are used in research with multiple methods (Saunders *et al.*, 2009).

3.5.2.1 Multi-method quantitative

Where two or more quantitative data-collection and corresponding data-analysis techniques are used in quantitative studies, they adopt the multi-method quantitative research-methodology choice (Saunders *et al.*, 2009). This research choice is common in fields involving primary or secondary sources of numerical data, such as pure sciences, economics, accounting, and finance.

3.5.2.2 Multi-method qualitative

This research methodology choice encompasses research involving qualitative data, where two or more qualitative data-collection and related data-analysis techniques are used (Saunders *et al.*, 2009). In research, where qualitative or non-numerical data is gathered, such as social sciences and anthropology, this research choice is appropriate. The advantage of combining multiple methods for collecting in-depth information from small samples is the ability to triangulate such information (Wilson, 2010). When a point in the data collection is reached where no novel information is collected, this implies data saturation (Sekaran and Bougie, 2009: 197). The major limitation of this research choice is the bias and subjectivity of the researcher, such that a mixed-methods choice is usually preferred.

3.5.3 Mixed methods

A combination of qualitative and quantitative methods for data collection and analysis is used within the same research study to counter the limitations of using a mono-method or multi-method qualitative or quantitative choice (Melnikovas, 2018). Mixed methods have a strong foothold in the pragmatist research paradigm (Cameron, 2009: 141). Three types of mixed-methods research are described by Creswell (2009): (1) sequential mixed methods (one data-collection/analysis method follows another); (2) concurrent mixed methods (numerical and non-numerical data-collection/analysis methods used in combination); and (3) transformative mixed methods (data collected and analysed sequentially or concurrently, but uneven priority of one method over another) (Tashakkori and Teddlie, 2003).

Several typologies are analysed by Cameron (2009), one of which described four types of mixed-methods research design based on the timing and mix (Creswell and Plano Clark, 2007). The characteristics of this typology are outlined in Table 3.2.

Table 3.2: A Typology of Mixed Methods Research Designs

Design Type	Timing	Mix
Triangulation	Concurrent: quantitative and qualitative at the same time	Merge the data during interpretation or analysis
Embedded	Concurrent and sequential	Embed one type of data within a larger design using the other type of data
Explanatory	Sequential: Quantitative followed by qualitative	Connect the data between the two phases
Exploratory	Sequential: Qualitative followed by quantitative	Connect the data between the two phases

Source: Creswell and Plano Clark (2007: 85).

Some disadvantages of mixed-methods research are described by critics (McMillan and Schumacher, 2006: 401). The researcher has to be proficient in both quantitative and qualitative research techniques and tools; and mixed-method research demands vast resources and efforts for data collection (McMillan and Schumacher, 2006).

3.5.4 Mixed-model research

Although mixed-methods and mixed-model research use both qualitative and quantitative methods, the former type uses these only in a single study; whereas the latter type uses these methods as part of a bigger research model or programme (Mertens, 2005: 292). Mixed-model research studies are complementary, each taking a different approach. Research projects following the mixed-model research choice involve multiple stages, each having its own objective, methods, data-collection and analysis tools and techniques (Tashakkori and Teddlie, 2003).

3.5.5 Research methodological choice adopted for this study

This study makes use of a multi-method quantitative-research methodological choice. The research objectives necessitate quantitative data to be collected and analysed to describe managers' knowledge and experience of Lean, and the application of factor analysis on independent variables to identify latent constructs. Structural equation modelling examines causal relationships between variables and latent constructs. Although one data-collection tool (a semi-structured questionnaire with predominantly quantitative-data focused questions) is used, multiple quantitative-data analysis techniques are applied sequentially.

3.6 Research Strategies

The next layer of the onion, research strategy or method, deals with how the researcher wishes to proceed with the collection of data to answer the research question(s) or to address the hypotheses (Creswell, 2009; Saunders and Tosey, 2013: 59). Thus, Melnikovas (2018:39) defines research strategy as "a general way which helps the researcher to choose main data collection methods or sets of methods in order to answer the research question and meet the research objectives". Several research strategies are described below, of which one or more may be used within a particular research philosophy, as determined by the underlying paradigm (Sarantakos, 2013; Saunders *et al.*, 2016).

3.6.1 Experimental studies

Experiments are operated in controlled, “closed” environments, in which researchers manipulate conditions with exposures, and observe the effects thereof whilst trying to control the environment which may influence the effects (Clarke, 2005). Experimental studies are usually associated with the positivist philosophy, and utilise deductive reasoning (Saunders and Tosey, 2013: 59). Manipulating or influencing the independent variables may result in an effect on the dependent variable, which is characteristic of the design of experimental studies (Vanderstoep and Johnston, 2009). In experiments, the researcher would divide the subjects into two groups or arms (case or treatment group, and control group), the manipulation occurring with the case group only (Sekaran and Bougie, 2009). The results of the manipulation of the cause-effect of independent on dependent variables are compared between the two groups (Sekaran and Bougie, 2009). A confounder or extraneous variable may sometimes make it difficult for the researcher to confirm whether the effect observed in the dependent variable was owing to the influence of the extraneous variable or independent variable (Vanderstoep and Johnston, 2009).

Research ethics are crucial in experimental studies, the non-laboratory experiments often involving human subjects who may be subjected to various forms of manipulation. Caution must be exercised in terms of research ethics when conducting experiments. Sekaran and Bougie (2009:251) describe some unethical practices in which researchers may engage, such as coercing subjects to participate with or without written consent, imperilling them with dangerous or risky exposures, misleading subjects to participate for unfair gains, and not respecting confidentiality and privacy.

The experimental research strategy is not appropriate to this study, as the manipulation of variables through subjecting them to exposures was not conducted. Experimental research design is usually inappropriate and difficult to incorporate into social science and business studies (Quinlan, 2011).

3.6.2 Quasi-experimental studies

As opposed to experimental studies, the research does not subject the independent variables to manipulation; but allows the social situation to do so (Bryman and Bell, 2011; Sekaran and Bougie, 2009). Cause-and-effect relationships are examined in both quasi-experimental and experimental studies. The researcher assigns subjects into groups in the latter type, in order to manipulate one group. In quasi-experimental studies, however, the researcher allows one group to be naturally manipulated by social conditions which the researcher cannot control (Sekaran and Bougie, 2009).

3.6.3 Surveys

Research designs adopting surveys fall within the positivist paradigm and employ quantitative methods for sampling, data collection, and analysis. Researchers draw sizeable samples from the target population from which to collect data, in order to provide "descriptions and explanations of perceptions, knowledge, trends, attitudes and other observations" (Creswell, 2009; Maylor and Blackmon, 2005). The data collection usually involves the use of structured questionnaires, interviews, and observations. Surveys can be classified according to the time dimensions across which their data collection is conducted.

This study fits the characteristics of a survey, as a large sample was drawn in order to identify and analyse senior health-care managers' perceptions and knowledge of Lean thinking; and to identify variables for the successful initiation of Lean. The study utilises a semi-structured questionnaire with mainly closed-ended and Likert-scale-type questions in order to produce quantitative data for analysis. A limited time frame and budget for the completion of this PhD research further justifies a survey approach. Unfortunately, no financial incentives or grants were provided for this study.

3.6.4 Exploratory studies

Exploratory studies assume open-mindedness in the search for new information and insights without asking reasons or offering justifications for their existence (Robson, 2002). A researcher would undertake an exploratory study to extend the frontiers of information and knowledge on a particular area of interest (Sekaran and Bougie, 2009).

The subject under investigation has to be familiar to the researcher to a certain extent, in order for him or her to obtain more insight prior to developing research hypotheses or questions (Sekaran and Bougie, 2009). This suggests that exploratory studies typically adopt an inductive research approach within the interpretivist research philosophy.

Data collection is usually attained through tools and techniques which seek undiluted information, such as focus-group discussions and unstructured interviews. Researchers adopt this strategy when there is a paucity of knowledge on a particular phenomenon (Sekaran and Bougie, 2009). Three steps should be followed by exploratory researchers: (1) literature review, (2) conducting of interviews with specialists on the topic under investigation, and (3) conducting focus-group discussions to obtain an expanded view of responses (Saunders *et al.*, 2009). As exploratory studies progress, broad knowledge and information obtained typically narrows down to simpler insights.

This study adopted some characteristics of exploratory research. The researcher had to be familiar with Lean to a certain extent in order to obtain more insight into its critical success factors. This would be prior to understanding the research gaps in existing literature, thereafter developing research questions (Sekaran and Bougie, 2009). Exploratory factor analysis was applied to the independent variables from the data-collection process in order to identify factors or determinants for successful Lean initiation.

3.6.5 Descriptive studies

Descriptive studies, as the terms implies, aim simply to “portray an accurate profile of persons, events or situations” (Robson, 2002). Descriptive studies rely on observations to gather rich and comprehensive data for new knowledge of the entity of interest (O'Gorman and MacIntosh, 2014). The research questions characteristically entail asking “who”, “what”, “where”, and “when”, but not “how” or “why”. Observations are usually recorded, to be later analysed (Clarke, 2005).

Descriptions of phenomena may either form the foundation for future exploratory or explanatory research where elaboration of information is required, or justifications for the existence of the information are sought; or they may be used to consolidate the information gathered from exploratory studies (Saunders *et al.*, 2009). Aiming to provide a comprehensive description of the phenomenon in question, descriptive studies, like exploratory studies, usually engage qualitative techniques and tools such as interviews and focus-group discussions.

Against this background, this study also took the form of descriptive research based on having an integrated approach (Ali and Birley, 1999). The study describes the “who”, “what”, “where” and “when” of Lean knowledge, experience, and perceptions among senior health-care managers in KwaZulu-Natal, using both analytical and descriptive statistics. The study also provides a description of the variables for successful initiation of Lean, as identified by participants.

3.6.6 Explanatory studies

This study strategy is appropriate for theory testing, when the researcher is seeking justification for existing or new-found information (O'Gorman and MacIntosh, 2014: 69). Explanatory studies seek to answer the “how” and “why” questions of research phenomena, and aim to provide explanations for causal relationships (O'Gorman and MacIntosh, 2014). Hypothesis testing is a major characteristic of explanatory studies, in which natures of association amongst variables are identified and explained (Sekaran and Bougie, 2009). Causal evidence is associated with temporal sequence (cause before effect), concomitant variation (resultant variation between the two variables under study), and non-spurious association (excluding confounders of the effect caused by a variable) (Zikmund, Babin, Carr and Griffin, 2012).

Explanatory studies are influential in scientific research as they normally identify reasons underlying particular processes, usually with a high degree of scientific reliability. They commonly involve a rigorous selection process, and offer superior internal validity (Zikmund *et al.*, 2012). On the contrary, some explanatory studies may not be able to reach particular conclusions from observed causal relationships. Such would be owing to several uncontrolled confounders or possible coincidences of cause-and-effect relationships (Zikmund *et al.*, 2012). These studies make use of one or more quantitative and quantitative data-collection techniques and tools to investigate patterns of relationships amongst variables.

This study did not aim to directly answer "how" and "why" questions relating to experience, knowledge and perceptions of Lean amongst senior managers. However, in identifying critical success factors through exploratory factor analysis and structural equation modelling, causal relationships and associations between independent and dependent variables (latent constructs) were tested. Structural equation modelling is justified in this study because it imputes relationships between latent variables from observable variables (Hancock, 2003). Hence, this study is classified as having explanatory research characteristics.

3.6.7 Case studies

A case study examines the context and the "particularity and complexity of a single case, coming to understand its activity within important circumstances" (Harrison, Birks, Franklin and Mills, 2017; Stake, 1995: xi). Case study characteristics are outlined in Table 3.3. Case studies may be classified under qualitative research; yet some philosophers argue that they may be orientated under positivist, realist, or even interpretivist philosophy (Harrison *et al.*, 2017). Nevertheless, various data-collection methods and several sources of data may be used in case studies (Creswell, 2014; Harrison *et al.*, 2017; Saunders *et al.*, 2009).

A case-study strategy was not useful for this study, as it did not require an in-depth look at a particular case or cases within a bounded system.

3.6.8 Ethnographic studies

Ethnography is a qualitative and inductive research approach involving the study of "social interactions, behaviours, and perceptions that occur within groups, teams, organisations and communities" (Reeves, Kuper and Hodges, 2008: 512). This research strategy is rooted in anthropology. The aim is to provide a holistic discernment of people's cultures, viewpoints, and the natural setting which they inhabit (Maylor and Blackmon, 2005: 144; Reeves *et al.*, 2008). Such a research involves tools such as personal or focus-group interviews and detailed observations of people (Creswell, 2009: 13). The key characteristics of ethnographic research are listed under Figure 3.5.

Table 3.3: Characteristics of Case Studies

Element	Description
The case	Object of the case study identified as the entity of interest or unit of analysis; Program, individual, group, social situation, organization, event, phenomena, or process
A bounded system	Bounded by time, space, and activity; Encompasses a system of connections; Bounding applies frames to manage contextual variables; Boundaries between the case and context can be blurred
Studied in context	Studied in its real life setting or natural environment; Context is significant to understanding the case; Contextual variables include political, economic, social, cultural, historical, and/or organizational factors
In-depth study	Chosen for intensive analysis of an issue; Fieldwork is intrinsic to the process of the inquiry; Subjectivity a consistent thread—varies in depth and engagement depending on the philosophical orientation of the research, purpose, and methods; Reflexive techniques pivotal to credibility and research process
Selecting the case	Based on the purpose and conditions of the study; Involves decisions about people, settings, events, phenomena; Scope: single, within case and multiple case sampling; Broad: capture ordinary, unique, varied and/or accessible aspects; Methods: specified criteria, methodical and purposive; Replication logic: theoretical or literal replication
Multiple sources of evidence	Multiple sources of evidence for comprehensive depth and breadth of inquiry Methods of data collection: interviews, observations, focus groups, artifact and document review, questionnaires and/or surveys; Methods of analysis: vary and depend on data collection methods and cases; need to be systematic and rigorous; Triangulation highly valued and commonly employed
Case study design	Descriptive, exploratory, explanatory, illustrative, evaluative; Single or multiple cases; Embedded or holistic

Source: Harrison *et al.* (2017).

- A strong emphasis on exploring the nature of a particular social phenomenon, rather than setting out to test hypotheses about it
- A tendency to work primarily with "unstructured data" —that is, data that have not been coded at the point of data collection as a closed set of analytical categories
- Investigation of a small number of cases (perhaps even just one case) in detail
- Analysis of data that involves explicit interpretation of the meanings and functions of human actions; the product of this analysis primarily takes the form of verbal descriptions and explanations

Figure 3.5: Characteristics of ethnographic research

Source: Hammersley and Atkinson (1995).

Ethnographers often immerse themselves in a research setting in which they conduct their observations. This provides the researcher with empirical information about participants' practices which would otherwise be "hidden" in that community (Reeves *et al.*, 2008). Reflexivity (the researcher's close relationship with the participants under investigation) is an important characteristic of ethnographic studies; it is usually represented through "thick descriptions" of the researcher's experiences (Reeves *et al.*, 2008). Ethnographic studies can consume a great deal of time and effort. Repeated access to the community for the purposes of observations and interviews may be difficult (Reeves *et al.*, 2008). This study does not involve the investigation of social interactions and behaviours of people; thus, the ethnographic research approach was not used in the study.

3.6.9 Action research

Action research is: (1) research in action and not about action, (2) participative, (3) research taking place concurrently with action, and (4) a problem-solving approach (Coughlan and Coghlan, 2002: 222). The researcher embeds action in the research process which informs his or her practices iteratively. Sekaran & Bougie (2009:31) describe action research as an approach which researchers embark upon to recommend improvements in production processes in which problems have been diagnosed. Action research is appropriate when the subject of enquiry relates to an evolving series of events, and where the researcher is a member of a group, analysing how his or her actions can impact on the system as well as how everyone can learn from these actions and outcomes (Coghlan and Brannick, 2001).

Four stages of action research have been described: (1) diagnosing, (2) planning, (3) action taking, and (4) evaluating (Saunders *et al.*, 2009: 148). In the diagnosing stage, the problem is identified and clearly defined using appropriate data-collection tools and analyses. Actions to solve the problem(s) are then formulated and effected, and finally, an evaluation of the impact is undertaken (Saunders *et al.*, 2009). This process may then be repeated for ongoing process improvements. Action research therefore provides solutions to problems, thus is an immediate but structured and scientific problem-solving approach. This approach was not used in the study.

3.6.10 Grounded theory

Several definitions of grounded theory are proposed by experts, all of which emphasise the construction of theory from a research process (Chun Tie, Birks and Francis, 2019). Grounded theory is "a set of integrated conceptual hypotheses systematically generated to produce an inductive theory about a substantive area" (Glaser and Holton, 2004: 43). The researcher allows for theory to emerge from the studied data (Strauss and Corbin, 1998: 12). As a form of qualitative research, grounded theory uses inductive analysis, and creates new theory or conceptual frameworks (Charmaz, 2006: 187).

Sekaran and Bougie (2009:297) explain that grounded theories are constructed through repeated purposive sampling, data collection, data analysis and coding (developing categories of information), until a state of "theoretical saturation" (where there is no new evidence about the topic) is reached. Figure 3.6 depicts a summary of the relationship between the key processes of grounded theory research. The grounded theory approach was not used in this study.

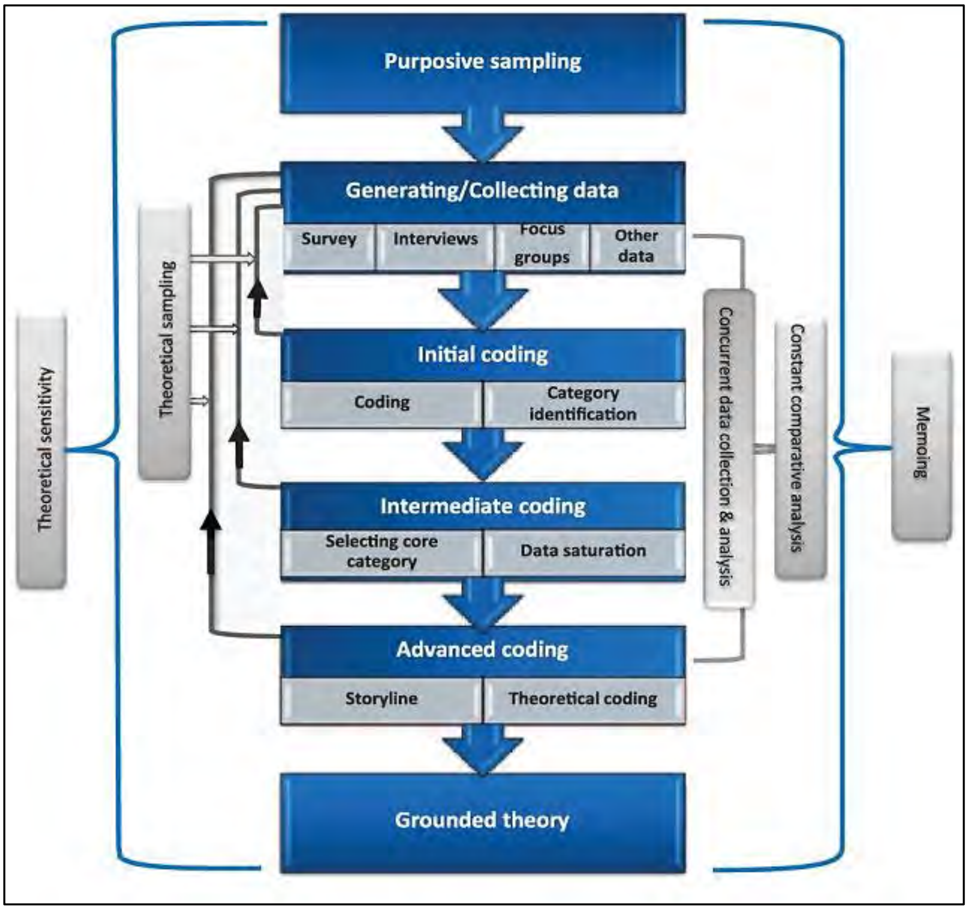


Figure 3.6: The relationship between the key processes of grounded theory research
Source: Chun Tie *et al.* (2019).

3.6.11 Archival research

Archival research uses secondary data sources in the form of documents from various archives of public and private bodies (Saunders *et al.*, 2009: 150). Accordingly, archival research is retrospective research based on recorded information and past events. There are both advantages and disadvantages to using secondary data sources or archival sources for research purposes, as listed in Table 3.4.

Table 3.4: Strengths and Weaknesses of using Secondary Data or Archival Sources

Element	**Strengths**	**Weaknesses**
Effort	Requires less cost and time in data collection and allowing more time for data analysis	Must be familiarised with the data. Need to manage large and complex data set. It may be expensive when data isn't free.
Analysis	Access to high quality data, comparing subgroups or subsets within the data sample; Comparing subgroups or subsets in other countries	Researchers lack control over the quality of the data; limitation to data that has been already collected; data may be biased in unobservable ways; data may lack the ability to answer key research questions.
Contribution	Re-interpretation of original findings by providing adequate analysis of the data set.	Lack rigorous and purposeful data collection from the primarily sources, does not build as many research skills as direct methods.

Source: Adapted from Maylor and Blackmon (2005: 173) and Atiku (2014: 138).

Other considerations when conducting archival research include the accuracy of the data, the regulations and laws governing access to archival data, the medium of storage of the data, and the cost to access the data. This research approach was not used in the study.

3.6.12 Research strategies adopted for this study

This study meets the criteria of an observational, cross-sectional survey incorporating a descriptive and explanatory research strategy. The need for the collection of data from a large sample at one point in time justifies the study being classified as a cross-sectional survey (Edmonds and Kennedy, 2012).

The experimental research strategy was considered inappropriate for this study, as the manipulation of variables through subjecting them to exposure was not conducted. This study fits the characteristics of a survey, a large sample having been drawn in order to identify and analyse senior health-care managers' perceptions and knowledge of Lean thinking; and to identify variables for the successful initiation of Lean.

The study makes use of a semi-structured questionnaire with mainly closed-ended and Likert-scale-type questions in order to produce quantitative data for analysis. A limited time frame and budget for the completion of this PhD research further justifies a survey approach.

The study matched some of the characteristics of exploratory research. The researcher had to be familiar with Lean to a certain extent in order to obtain rich insight (from the literature review) on its critical success factors prior to understanding the research gaps in existing literature and developing research questions (Sekaran and Bougie, 2009).

The study also took the form of descriptive research based on having an integrated approach. The research describes the “who”, “what”, “where”, and “when” of Lean knowledge, experience, and perceptions among senior health-care managers in KwaZulu-Natal, employing both analytical and descriptive statistics. A description of the variables for successful initiation of Lean, as identified by participants, was also provided and used in exploratory factor analysis to identify latent constructs.

This study did not aim to directly answer “how” and “why” questions relating to experience, knowledge and perceptions of Lean amongst senior managers. However, in identifying critical success factors through exploratory factor analysis and structural equation modelling, causal relationships and associations between independent and dependent variables (latent constructs) were tested. Structural equation modelling is justified in this study because it imputes relationships between latent variables from observable variables (Hancock, 2003). Hence, this study is classified as having explanatory research characteristics. The researcher acknowledges that this research strategy allows for the inference of causation through application of structural equation (causal) modelling.

Ultimately, with the aim of achieving the objectives of the research, the researcher considers the above research strategy most appropriate. Similar studies which were analysed in the literature review also justify using the above research strategy (Al-Najem, 2014; Losonci, Demeter and Jenei, 2011; Vermaak, 2008).

3.7 Time Horizon

3.7.1 Cross-sectional studies

An observational study in which data is collected in at one point (or a ‘snapshot’) in time is referred to as a cross-sectional study (Setia, 2016; Wilson, 2010: 112). These studies are generally quicker and less expensive than longitudinal studies, since data collection occurs only at one point in time (Setia, 2016; Wilson, 2010). On the contrary, these studies are often disposed to bias, making it difficult to affirm causal relationships (Setia, 2016). Researchers undertaking cross-sectional studies generally make use of surveys or case studies (Saunders and Tosey, 2013: 59).

3.7.2 Longitudinal studies

When data is required to be collected continuously or repeatedly over a period of time, longitudinal studies are appropriate (Caruana, Roman, Hernández-Sánchez and Solli, 2015; Saunders *et al.*, 2009: 155; Sekaran and Bougie, 2009: 112). They can be used to determine the sequence of events, and to identify effects in relation to exposure over a period of time (Caruana *et al.*, 2015). There are three main categories of longitudinal studies: (1) repeated cross-sectional (different participants at every data-collection occasion), (2) prospective (participants are tracked over a period of time), and (3) retrospective studies (examining participants who have already experienced events) (Caruana *et al.*, 2015).

Longitudinal studies are usually observational; and employ one or more quantitative or qualitative tools and techniques for the collection of data on a host of exposures and outcomes (Caruana *et al.*, 2015). Unfortunately, these studies are generally more expensive, therefore more effort and time is required to conduct such studies.

This study involved a cross-sectional survey as data was collected at only one point in time, as described above.

3.8 Study Site and Target Population

There are varying definitions of the concept of target population. A simple definition of population provided by Saunders *et al.* (2009) is that it is the "entire group from which a sample is drawn". A rather vague definition provided by Wilson (2010:306) is that a population is a "clearly defined group of cases on which a research can draw [a sample from]" (Wilson, 2010: 306). A more comprehensive definition provided by Sekaran and Bougie (2009: 262) is that the target population is "the entire group of people, events or things of interest that the researcher wishes to investigate".

The research was conducted in KwaZulu-Natal (KZN), South Africa, which is the second-highest populated of the nine provinces in the country (KZN Department of Health, 2017). KwaZulu-Natal is located on the east coast of the country, and, in 2017, consisted of approximately 11 074 784 citizens, according to Stats SA mid-year population estimates (KZN Department of Health, 2018a). Within KZN are found 1 Metropole (eThekwini), 10 districts, 50 municipalities, and 828 municipal wards scattered across an area of 92100 square kilometres (KZN Department of Health, 2014) (Table 3.5).

Table 3.5: Study Site and Population

General, target and study populations	**General Population**	**Target population**	**Study population**
	All executive and senior managers in all public hospitals in South Africa	Approximately 500 executive and senior managers working in 73 public hospitals in KwaZulu-Natal, South Africa	Simple random sampling was used to select a sample from a study population of executive and senior managers working in 73 public hospitals in KwaZulu-Natal, South Africa
Study site	**KwaZulu-Natal, South Africa (92100 km^2)**	**Population size (Stats SA)**	**Managers included in the study**
	73 public hospitals serving 1 Metropole, 10 districts, 50 municipalities and 828 municipal wards	11 074 784 people living in KwaZulu-Natal	Hospital executive managers, assistant managers, operational or unit managers and managers of clinical departments

Source: (KZN Department of Health, 2014, 2018a).

Based on the definitions provided above, the target population resided within the 73 public and state-aided hospitals categorised per district in Table 3.6, and consisted of approximately 500 senior managers comprising the following ranks (whether or not acting in the position): hospital executive managers, assistant managers, operational or unit managers, and managers of clinical departments.

Table 3.6: Public Health Facilities in KwaZulu-Natal

Health District	**Primary Health Care (PHC) facilities**			**Hospitals (Public + State Aided)**							
	Fixed Clinics	Community Health Centers	**Total PHC Facilities**	District	Regional	Tertiary	Central	Specialised Tuberculosis	Specialised Psychiatric	Chronic/Sub-acute	**Total Hospitals**
Ugu	51	2	**53**	3	1	0	0	1	0	0	**5**
Umgungundlovu	50	3	**53**	2	1	1	0	2	3	0	**9**
Uthukela	36	1	**37**	2	1	0	0	0	0	0	**3**
Umzinyathi	53	1	**54**	4	0	0	0	0	0	0	**4**
Amajuba	25	1	**26**	1	2	0	0	0	0	0	**3**
Zululand	71	1	**72**	5	0	0	0	1+2	1	0	**9**
Umkhanyakude	57	0	**57**	5	0	0	0	0	0	0	**5**
King Cetshwayo	63	1	**64**	6	1	1	0	0	0	0	**8**
iLembe	34	2	**36**	3	1	0	0	0	0	0	**4**
Harry Gwala	39	1	**40**	4	0	0	0	1	1	0	**6**
eThekwini	119	8	**127**	3+1	6	1	1	2	1	2	**17**
TOTAL	**598**	**21**	**619**	**39**	**13**	**3**	**1**	**9**	**6**	**2**	**73**

Source: KZN Department of Health (2018b).

3.9 Inclusion and Exclusion Criteria

The target population must be delineated as a sampling frame from which the sample will be drawn (Taherdoost, 2016). The sampling frame is defined by specifying the inclusion and exclusion criteria, thus limiting the sampling process to the sampling frame which must be representative of the population (Taherdoost, 2016).

Any of the executive or senior managers mentioned above who declined participation from the study were excluded. Managers working in the Provincial Head Office and District Offices were excluded from the study.

All managers within the ranks of executive management (hospital manager, medical manager, nursing manager, finance manager, systems manager, maintenance manager and human-resources manager) and senior management (assistant managers, operational or unit managers and managers of clinical departments) and who were on duty, based in any of the 73 public hospitals in KZN, were included in the sampling frame, irrespective of duration in the post and whether or not acting in a vacant position. Operational or unit managers are nurses who oversee wards or units within a hospital.

3.10 Sampling Technique

A sample is a representative subset of the population of interest in a study (Wilson, 2010). Sampling is necessary to ensure that a representative group of subjects is selected from which the results of the research can be generalised to the population of interest. One of the main reasons for sampling is that there is often difficulty in reaching all subjects within large populations from which to collect data (Saunders *et al.*, 2009). Time constraints and cost implications are also huge drawcards for sampling (Saunders *et al.,* 2009).

Sampling is classified into two techniques: probability and non-probability sampling, as summarised in Figure 3.7. Probability sampling includes: simple random, stratified random, systematic, and cluster sampling (Wilson, 2010). The types of non-probability sampling include: purposive sampling, snowballing, quota, and convenience sampling (Wilson, 2010). Each sampling technique has its own known advantages and disadvantages, as summarised in Figure 3.8.

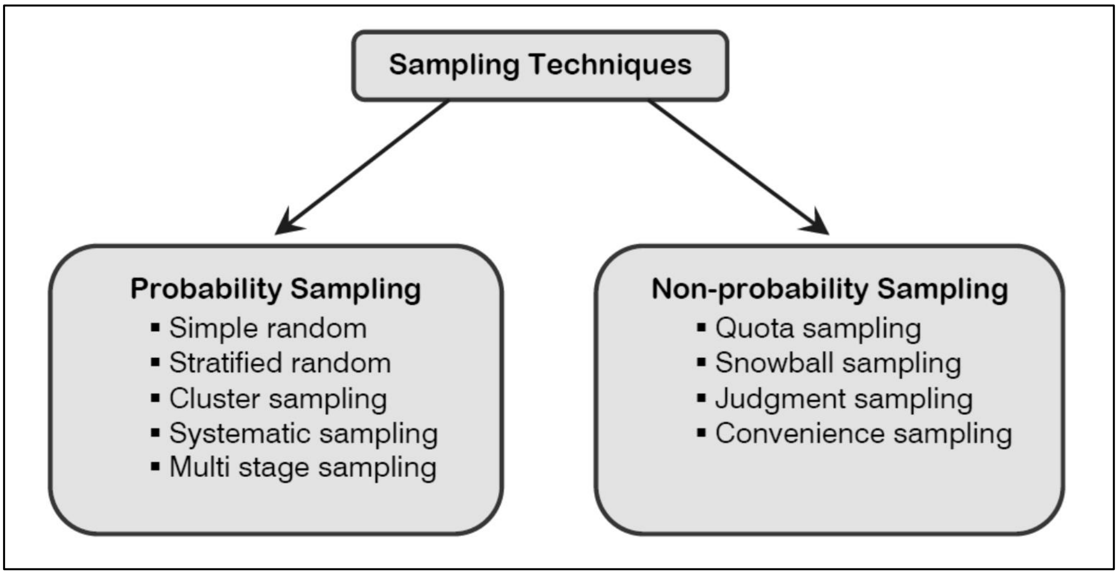


Figure 3.7: Sampling techniques

Source: Taherdoost (2016).

Sampling technique	Advantages	Disadvantages
Convenience sampling	Least expensive, least time-consuming, most convenient	Selection bias, sample not representative, not recommended by descriptive or casual research
Judgment sampling	Low-cost, convenient, not time-consuming, ideal for exploratory research design	Does not allow generalization, subjective
Quota sampling	Sample can be controlled for certain characteristics	Selection bias, no assurance
Snowball sampling	Can estimate rare characteristics	Time-consuming
Simple random sampling	Easily understood, results projectable	Difficult to construct sampling frame, expensive, lower precision, no assurance of representativeness
Systematic sampling	Can increase representativeness, easier to implement than simple random sampling, sampling frame not always necessary	Can decrease representativeness
Stratified sampling	Includes all important sub-population, precision	Difficult to select relevant stratification variables, not feasible to stratify on many variables, expensive
Cluster sampling	Easy to implement, cost-effective	Imprecise, difficult to compute an interpret results

Figure 3.8: Advantages and disadvantages of the sampling techniques

Source: Malhotra and Birks (2006).

3.10.1 Probability (or random) sampling

Probability sampling is also known as random sampling. In this type of sampling, each element in the target population has a known chance or probability of being selected in the sample (Sekaran and Bougie, 2009). Random sampling has the advantage of being more free from bias than non-probability sampling (Brown, 1947).

3.10.1.1 Simple random sampling

In simple random sampling, each sampling unit has an equal and known chance or probability of being selected (Taherdoost, 2016). For example, if the sample size required was 20 and the target population was 100, then the probability (P) of being included in the sample would be 20% or 0.2, calculated as follows:

$$P\ (inclusion\ in\ sample) = \frac{20}{100} = 0.2$$

Simple random sampling can be very time consuming to conduct; and the researcher has to know all the elements in the full sampling frame (Sekaran and Bougie, 2009: 270).

3.10.1.2 Systematic sampling

With this sampling technique, the researcher selects every n^{th} subject from the sampling frame until the sample size is reached, after the first subject is selected randomly (Saunders *et al.*, 2009; Taherdoost, 2016). Although it is a simple technique, the whole sampling frame has to be known.

3.10.1.3 Stratified random sampling

Stratified random sampling aims to ensure that subgroups of the population being studied are adequately represented. This is achieved by categorising the population into strata (subgroups) based on particular characteristics that they naturally possess, the researcher then selecting units from each stratum randomly (Taherdoost, 2016). Stratified random sampling consists of four stages (Wilson, 2010: 196): (1) Identify a variable for stratifying the population, (2) Segregate the population into subgroups based on such variable(s), (3) allocate unique identifiers to the sampling units, and (4) choose sampling units using simple random or systematic random sampling.

3.10.1.4 Cluster sampling

The population is split into clusters based on specific criteria such as geographic location, random samples being drawn from each (Taherdoost, 2016; Wilson, 2010). This form of sampling is useful for widely dispersed populations. Taherdoost (2016:21) describes three stages for cluster sampling: (1) select a characteristic for clustering the population, (2) allocate numbers to the clusters, and (3) sample randomly from each cluster.

3.10.1.5 Multi-stage sampling

With multi-stage sampling, the population is sampled in phases, such that the sampling frame is reduced from a broad population dispersion to a smaller location. For example, a country may be divided into clusters or regions, regions then being randomly selected. Thereafter, the regions may be subdivided into municipalities, which are then randomly sampled. This process is repeated until the samples are concentrated in a few geographical areas (Taherdoost, 2016).

3.10.2 Non-probability sampling

When a researcher has a clear reason or justification for including specific subjects in his study, non-probability sampling becomes necessary (Taherdoost, 2016). As there is subjectivity in the sampling technique, non-probability sampling is associated with qualitative studies falling within the interpretivist paradigm. Usually, smaller samples are drawn for these studies, from which generalizations of findings through statistical inference are usually not required (Yin, 2003).

3.10.2.1 Quota sampling

Quota sampling involves purposefully selecting sampling units based on characteristics which resemble population characteristics (Taherdoost, 2016). Although Saunders *et al.* (2009) liken quota sampling to stratified sampling, the major difference is that, in quota sampling, samples are drawn in a non-random manner from each stratum or subgroup.

3.10.2.2 Snowball sampling

When a participant refers the researcher to other possible participants, who in turn also identify other potential subjects for the research, this is known as snowball sampling (Taherdoost, 2016). This is a non-random technique that is useful in poorly accessible communities or societies which are often "hidden" from the public eye, such as sex-workers, and drug dealers (Brewerton and Millward, 2001; Taherdoost, 2016).

3.10.2.3 Convenience sampling

When the researcher samples the population predicated on convenience to both the research and participants, as well as the participants' accessibility and willingness to participate, this is referred to as convenience sampling (Sekaran and Bougie, 2009). Convenience sampling can be cost-effective and quick, as the researcher carries out sampling based on expediency to participate.

3.10.2.4 Purposive or judgmental sampling

Purposive or judgmental sampling is seen when the researcher consciously selects study sites or participants which would provide the information required in order to meet the objectives of the study (Taherdoost, 2016). The researcher uses own judgement when selecting participants, in order to achieve the research objectives. This sampling technique is useful when the research involves a "certain cultural domain with knowledgeable experts within" (Tongco, 2007: 153).

3.10.3 Sampling techniques used in this study

Based on the definition by Sekaran and Bougie (2009: 262), all categories of approximately 500 senior and executive managers mentioned above at all 73 public hospitals in KZN formed the target population. These are the key role-players in operational and strategic decision-making within each hospital. Managers selected from the target population provided valuable input into the identification of variables for the successful initiation of Lean. These managers will also be instrumental in rolling out Lean if Lean SPRInT is adopted by the KZN Department of Health.

3.10.3.1 Selection of the province

Purposive sampling was used to select the public hospitals located in the province of KZN in which to conduct the study. The researcher wanted to focus his enquiry on KZN, as Lean is not yet broadly applied in public hospitals in the province. Convenience sampling was also used to select the province. The researcher resides in KZN and is familiar with the management structures and job roles of managers within the hospitals in KZN. Furthermore, a limited research budget and constraint to complete the PhD research within a specific time frame also favoured the selection of KZN for convenience.

3.10.3.2 Selection of senior managers in hospitals

Since the gathering of information from senior health-care managers (target population) was the area of focus in terms of the study objectives, simple random sampling was applied to the target population to select a representative number of participants. The sample selection was guided by the sample size calculations described below, and the inclusion and exclusion criteria described above.

Although the target population consists of different categories of managers, such as human resource managers and finance managers, all managers were considered as being part of one combined target population on which simple random sampling was conducted. It was not necessary to divide the target population into strata prior to the sampling process, since the focus of the study was not to distinguish data from each subgroup or category of managers. The participant inclusion criteria for the study was not a basis for stratification of the population; it only describes which categories of managers were included in the study. Stratified random sampling requires that the target population be divided into strata based on a particular criterion and then simple random sampling is applied to each stratum. This was not done in this study.

The researcher sampled the required number of participants using simple random sampling by approaching managers from the above-mentioned categories who met the inclusion criteria. Such participants were interviewed during their lunch and tea breaks at work over a data-collection period of approximately two months, until the desired sample size was acquired.

3.11 Sample size

Sampling error is reduced when the sample size is larger; however, the diminishing returns of sample representativeness of the population must be weighed against the resources available for conducting the sampling (Taherdoost, 2016). Since this study involves factor analysis which would play a role in determining the sample size, it is important to first determine the required sample for exploratory factor analysis.

A reliable sample size for exploratory factor analysis is one which contains *n* subjects for every test item (*p*), where *n* equals at least 5 (Costello and Osborne, 2005). Some factor analysis experts argue that the *n*:*p* ratio should be at least 3 to 6 per test item; whilst others recommend a minimum of 5 per test item (Cattell, 1978; Costello and Osborne, 2005; Gorsuch, 1983). Table 3.7 shows that a larger proportion (cumulative percentage of 63.2%) of studies use between 2 and 10 subjects per test item. There is no hard and fast rule apropos of the sample size for exploratory factor analysis.

In this study, there are 32 test items in the questionnaire. As a result, for reliable factor analysis, a minimum sample size of at least 192 (based on a subject: item ratio of 6:1) was required. Based on a table of sample sizes determined by the level of desired accuracy (Annexure P), the planned sample size of senior managers, considering a 5% margin of error and 95% level of confidence, was 218, which would be sufficient for reliable factor analysis (Gill, Johnson and Clark, 2010).

Table 3.7: Factor Analysis Sample Sizes in Current Practice

Subject to item ratio	% of studies	Cumulative %
2:1 or less	14.7%	14.7%
>2:1, ≤ 5:1	25.8%	40.5%
>5:1, ≤ 10:1	22.7%	63.2%
>10:1, ≤ 20:1	15.4%	78.6%
>20:1, ≤ 100:1	18.4%	97.0%
>100:1	3.0%	100.0%

Source: Costello and Osborne (2005).

The sample size can be regarded as acceptable if the communalities are high (squared multiple correlation > 0.6) and factors relatively few in number. MacCallum *et al.* (1999) explain that, with the above conditions, the “investigator can be confident that obtained factors represent a close match to population factors even with moderate to small sample sizes” since the *n*:*p* ratio recommendations above may not be invariant across studies (MacCallum, Widaman, Zhang and Hong, 1999: 97).

The communality of a variable (frequently estimated by squared multiple correlation) can be defined as “the portion of the variance of that variable that is accounted for by the common factors” (MacCallum *et al.*, 1999).The authors further recommend *post hoc* judgement of the adequacy of the sample size used for factor analysis, by examining communalities and number of factors. Consequently, in terms of MacCallum *et al.*’s (1999) proposition, factor analysis in this study showed that communalities are high (mostly above 0.6) and factors few in number (3 factors), hence the sample of 211 which was obtained can be considered reliable (MacCallum *et al.*, 1999).

3.12 Data-collection Methods

3.12.1 Research instrument

The research instrument that was used in this study was a self-administered, semi-structured questionnaire (Annexure B) with mixed categorical, open-ended and variable Likert-scale questions. It was developed with the assistance of a statistician, following detailed literature review to understand which research questions needed to be answered. The research objectives necessitated quantitative data to be collected and analysed to describe managers’ knowledge and experience of Lean, and to apply factor analysis on independent variables to identify latent constructs. Structural equation modelling examines causal relationships between variables and latent constructs. Although one research instrument is used, multiple quantitative data-analysis techniques were applied sequentially, thus necessitating a multi-method quantitative-research methodological choice.

Saunders *et al.* (2009) adequately summarise the three types of data variables which questionnaires are usually designed to gather: opinion, behaviour, and attributes. Attributes describe the demographic characteristics of participants. Behaviour variables usually collect data on participants' past, present, or future actions, in response to a certain stimulus or exposure. An example of questions relating to behaviour is an enquiry into how managers may react were Lean thinking to be rolled out in KZN hospitals. Variables relating to opinions educe information on participants' subjective views on a certain issue. The questionnaire used in this study collects all three types of data variables in its three sections, as described below.

The questions used employed mixed nominal, ordinal, and interval measures. The questionnaire is divided into 3 sections:

(A) General information (attributes): categorical questions for job profiling.

(B) Knowledge and experience with Lean (opinions and behaviour): mixed categorical, variable Likert-scale and open-ended questions to obtain information regarding the participants' knowledge and experience with Lean in their career lifetime.

(C) Key variables for successful initiation of Lean (opinions): a total of 32 randomly organised 6-point Likert-scale questions based on 8 critical-success-factor categories isolated in Vermaak's (2008) research: "mind-set and attitude, leadership, ordinary employees, strategic driver, basic stability, Lean promotion office, tools and techniques and integration" (Vermaak, 2008).

The researcher, with permission, utilised the same categories of variables as found in Vermaak's (2008) study, in the research questionnaire. The difference, however, was that these ***independent*** variables could only be labelled "critical success factors" after factor analysis and structural equation modelling had been carried out. This section of the questionnaire comprised 6-point Likert-scale questions in which participants were given a range of options to score their responses (Ghauri and Grønhaug, 2010).

3.12.2 Advantages and challenges with using the research instrument

Some of the benefits of using a questionnaire in this study were:

(i) It was time-saving and cost-effective, owing to the ease of distribution via email for remote hospitals.

(ii) The questionnaire was administered in a short space of time mainly because of close-ended and Likert-scale questions.

(iii) All three data variable types were collected (attributes, opinions, and behaviours).

(iv) The questionnaire was developed jointly with a statistician; thus, the scientific rigour was improved.

(v) The questionnaire was structured into three sections which were aligned with the research objectives.

(vi) The questionnaire allowed for easy data collation, owing to the nature of the variables.

One of the major challenges, considering the research budget limitation, was the distribution of questionnaires by hand to managers who did not respond via email. Some questionnaires were incomplete for unknown reasons. The researcher often had to remind participants to return their consent forms with the completed questionnaires. The researcher overcame some of these challenges by undertaking to meet with some of the hospital managers to request that they encourage staff to participate. The researcher also obtained permission from the hospital managers to enter the institutions to collect data as they were the accounting officers thereof.

3.12.3 Data-collection process

Information sheets, consent forms, and questionnaires were hand-delivered to randomly selected participants who met the inclusion criteria described above, using simple random sampling. Where it was difficult to reach the participant personally, questionnaires were emailed to them using their work email addresses as found on the Department of Health’s global address book. Where participants could not be reached by email or personally, the documents were distributed via their institution’s hospital manager.

Completed consent forms and questionnaires were emailed back to the researcher as indicated on the information sheet, or dropped off in a sealed collection-box located within the respective institution. Wherever the participant was not able to email the consent forms and questionnaires, arrangements were made to fetch the collection boxes from the respective facilities.

3.13 Data Quality Control: Validity and Reliability

Validity broadly concerns the best approximation to the truth, the soundness of the study's findings, and whether findings are unbiased, rational, and well-grounded (Polit and Beck, 2008). In terms of content validity, some measures from the instrument that were used to collect data had been tested amongst managers in previous research conducted by Vermaak (2008) on a larger (national) scale than the proposed research. The contents of the Likert-scale questions in the questionnaire could be applied to any industry (service or production), as the questions were generic. Extensive literature review had been conducted in the development of the instrument to ensure that it tested what it was intended to measure. Face validity was improved by a detailed information sheet which engaged the participant in the measurement instrument.

A large enough sample size was aimed for, with a level of significance (α) of 0.05 and confidence level of 95%. Since the target population of senior managers in KZN public hospitals had been selected purposively, and for convenience (non-probability sampling), the generalizability of the descriptive results is intended for the target population of senior health-care managers only, within the province of KZN. Within this target population, sample selection was based on probability using simple random sampling, thus allowing for the results to be generalizable to the senior managers in the target population.

Selection bias was reduced by randomly selecting participants from the target population. Samples were not selected based on convenience because questionnaires were sent out via email and hand-delivered to those who were unreachable via email. Therefore, remotely located hospitals were not excluded from the selection process, as this is often what jeopardizes validity. Measurement bias was almost eliminated owing to the majority of the questions being closed-ended, Likert-scale type, categorical, or binary.

Reliability is defined as "the extent to which results are consistent over time… and if the results of a study can be reproduced under a similar methodology, then the research instrument is considered to be reliable" (Golafshani, 2003). Reliability of the research instrument is enhanced, owing to the job profiles of the selected management categories all being standardised across the province. Therefore, it is expected that most managers of a management category would be similar in their levels of skill, knowledge, and expertise within that specific job rank. For example, hospital managers from the entire target population would have a similar role to play since the job descriptions and requirements of the incumbents are standardised by the KZN Department of Health. Consequently, if test-retest reliability and consistency were to be examined, the instrument is expected to yield similar results for the reasons described above. Close-ended questions also contribute to reliability.

To assess whether the confirmatory factor analysis (CFA) measurement model was acceptable, structural equation modelling (SEM) non-centrality-based fit indices were assessed (Table 3.8).

Table 3.8: Structural Equation Modelling (SEM) Non-centrality-based Fit Indices

SEM Fit Index	Recommended cut-off value	Value for this model
Root mean square error of approximation (RMSEA)	<0.08 (Browne and Cudeck, 1993; Hu and Bentler, 1995) Some authors allow <0.10 for a fair/mediocre fit (MacCallum, Browne and Sugawara, 1996)	0.085
Comparative fit index (CFI)	≥0.95 (Bollen, 1990; Hu and Bentler, 1999)	0.956
Relative or normed Chi square (X^2 / df)	<5 (Schumacker and Lomax, 2004a)	2.513

In terms of the resultant CFA model, the following conditions were required for reliability and validity of the model:

- Reliability: Composite reliability (CR) > 0.7 and loadings on factors > 0.5
- Convergent validity: CR > Average variance extracted (AVE) and AVE > 0.5
- Discriminant validity: AVE > squared correlations

For this model, Table 3.9 shows the values of the indices used to assess for reliability and validity, based on the conditions specified above. Diagonals represent AVE, and Alpha represents Cronbach's alpha reliability measure. Off-diagonals represent squared correlations (also known as shared variance).

Table 3.9: Squared Correlations, Composite Reliability, Average Variance extracted and Cronbach's Alpha for Current Model

	Squared correlations				
Construct	**F1**	**F2**	**F3**	**CR**	**Alpha**
F1	0.632			0.932	0.934
F2	0.484	0.639		0.775	0.715
F3	0.619	0.576	.631	0.773	0.763

All reliability and validity conditions have been met, thus rendering the model reliable and valid.

3.13 Data Analysis

3.13.1 Descriptive statistics

Quantitative data is analysed and interpreted through the use of diagrams and statistics, whereas qualitative data is analysed through the use of conceptualization (Ghauri and Grønhaug, 2010). Descriptive statistics are a collection of statistical methods used to summarise or describe numerical data (Wilson, 2010: 213). The use of the tools of descriptive statistics, such as frequency distribution tables, graphs, histograms, and pie charts, to represent numerical data, is appropriate for categorical data, as exhibited in the research instrument of this study (Wilson, 2010). Wilson (2010) asserts that descriptive statistics provide readers with a broad introduction or summary of the data collected. In this study, descriptive statistics were used to demonstrate the results of demographic and job-profile data. Statistical analysis on descriptive data was conducted using the Statistical Package for the Social Sciences (SPSS®) software.

3.13.2 Cronbach's alpha coefficient

Cronbach's alpha coefficient can be used as a data quality-control statistical test for determining level of consistency of a data set (Pallant, 2011). Cronbach's alpha coefficient is a reliability statistical test which calculated the extent to which items in the data-collection tool are positively correlated (Sekaran and Bougie, 2009: 324). Cronbach's alpha coefficient was used to determine the internal consistency of the test items contained in the questionnaire, looking particularly for unidimensionality (homogeneity) of items measuring latent constructs (Tavakol and Dennick, 2011). Cronbach's alpha generally greater than 0.7 is considered acceptable (Tavakol and Dennick, 2011).

3.13.3 Factor analysis

Data was reduced using exploratory factor analysis (EFA) to identify latent constructs. Exploratory factor analysis (EFA) was conducted on SPSS® and used to determine the latent constructs (critical success factors) underlying a set of variables (Costello and Osborne, 2005). EFA also served the purpose of explaining variation among variables by condensing them into only a few variables (factors or latent constructs) (Costello and Osborne, 2005). EFA also helped with characterising the content and meaning of the new factors.

3.13.4 Structural Equation Modelling

Structural equation modelling (SEM) facilitates the measurement of the relationships among multiple dependent and independent variables simultaneously (Katou and Budhwar, 2010; Luna-Arocas and Camps, 2007; Ullman, 2006). SEM is a set of 'complex statistical models of linear relationships among latent and manifest variables' (Sekaran & Bougie, 2009:365). Reasons for using SEM in this study include the following: (1) to provide a basis for modelling of latent (unobserved) and manifest (observed) variables, and (2) to examine several structural associations concomitantly (Prajogo and McDermott, 2011; Prajogo and Sohal, 2006; Škerlavaj, Štemberger, Škrinjar and Dimovski, 2007).

AMOS (Analysis of a Moment Structures) version 21 was used for carrying out SEM. According to Duff and Duffy (2002), AMOS is a statistical software package that is able to conduct SEM where there is a need for multivariate data analysis.

SEM ultimately led to the identification of critical success factors for Lean initiation. Once critical success factors had been identified, the Lean SPRInT tool was developed using Microsoft Excel®, as described in Chapter 7.

3.14 Ethical Considerations

Research ethics approval was obtained from the Human Social Sciences Research Ethics Committee (HSSREC) at UKZN (HSS/0031/016D) (Annexure E). Re-certification of ethics approval was sought owing to the expiry of the initial approval (Annexure F). An amendment to the approval was necessary, owing to the addition of a PhD co-supervisor (Annexure G).

Gatekeeper permission for the research (Annexure C) and for publication of the results (Annexure H) were granted by the KZN Department of Health's Provincial Health Research and Knowledge Management unit (HRKM22/16). Gatekeeper's permission was also obtained from the Department of Health's Deputy Director General: Specialised Services and Clinical Support at the time of obtaining permissions (Annexure D). Permission was sought from the author of a PhD research (Vermaak, 2008) for the use of elements from his research questionnaire in the development of the research instrument for this study.

Informed consent was obtained from all participants. Participation was voluntary and participants were allowed to withdraw at any point. Permission was also sought from the journal managing editors for the use of the published articles verbatim in this thesis (Annexure N and Annexure O).

Electronic, self-administered questionnaires were sent via Microsoft Outlook® encrypted emails via a secure environment, or hand-delivered to participants. Questionnaire responses were received via email and/or personally collected by the researcher and his assistant, anonymised, and stored in electronic folders or lever-arch files. Electronic folders will be securely stored for 5 years on the researcher's personal laptop which is password-protected and firewalled, and hard copies will be kept in a lever-arch file, which will be locked in a cupboard at his residence. No personal details of participants were obtained via the questionnaires or published in any form.

3.15 Summary

The chapter provided details of the research approach in terms of the research paradigm and design of the study. The study site and target and study populations were described, followed by an explanation of the sampling method and the required sample size. Data-collection methods, data quality control and data analysis were elaborated on. The chapter concluded with a description of the ethical considerations for the study. The next chapter represents the first of five articles compiled from this study.

4. CHAPTER FOUR: ARTICLE 1: AN OVERVIEW OF CRITICAL SUCCESS FACTORS FOR LEAN IMPLEMENTATION IN HEALTH CARE

4.1 Introduction

The last chapter provided a comprehensive description of the research methodology used in this study. This chapter represents the first of five articles compiled from this study. This article is entitled "*An Overview of Critical Success Factors for Lean Implementation in Health Care*". The purpose of this chapter is to provide an overview of the available literature, both worldwide and local, which synopsises the CSFs for Lean implementation in both health-care and non-health-care industries. The reviewed literature contextualises the research in terms of the CSFs which have been previously identified for Lean implementation in various industries, and serves as a backdrop for the study. The chapter describes the South African context of health-care management, worldwide context of CSFs for Lean, and the health-care context of CSFs for Lean implementation.

In October 2019, the article was submitted to the South African Health Review for consideration for publication in the SAHR 2020 edition, and is now under review (Annexure I).

4.2 Article submitted to journal

ABSTRACT

Lean is a fast-growing management approach for achieving sustainable recuperation in the delivery of health care with limited resources. Literature reviews on the critical success factors (CSFs) for Lean implementation in health care are scarce. This manuscript serves to provide a cursory overview of key literature available on CSFs for Lean, both within and external to the health-care sector. The South African Department of Health has embarked on a journey towards universal health coverage of the population. Several government strategic documents describe health systems reforms and strengthening as a way forward. However, the answers to how management systems can be overhauled are left wanting. Common to most literature reviewed are the following CSFs: management commitment, that is, communicating a clear vision with a long-term plan to succeed, change management, and an integration of organisational resources. At least two reviewed studies which attempted to identify CSFs for Lean implementation were conducted in South Africa. In the health sector, there is a meagreness of studies which uncover CSFs, especially in South Africa. Some researchers merely describe the challenges and barriers of Lean implementation in the health sector, without identifying CSFs. Most of the available and reviewed literature describing various CSFs for Lean implementation in the health-care sector demonstrated that the CSFs shared traits similar to those identified in the non-health-care sectors.

Keywords: Lean Critical Success Factors; Lean health care; CSFs for Lean; Lean readiness

INTRODUCTION

A fast-changing and highly volatile milieu for health-care delivery in South Africa, in view of its quadruple burden of communicable, non-communicable, perinatal and maternal, and injury-related disorders with generally poor health outcomes, is compelling enough for health-care managers to adopt contemporary management approaches that are shown to be effective in resource-constrained environments (Coovadia *et al.*, 2009; Mayosi and Benatar, 2014; Whiteside, 2014). In order to achieve sustainable recuperation in the delivery of health care with limited resources and with recently poor prospects for economic growth, efforts have to be made towards improved health-care management and "doing better with less" (Mayosi and Benatar, 2014). Lean, whose primary focus is on reducing waste, synchronising flows, and managing variability in (process) flows, is one such fast-growing approach which uses tools and techniques that are easily adaptable and suitable for application in hospitals.

Successful Lean initiation is the cornerstone to developing a fully-fledged Lean management system which can be used to identify and resolve operational problems while reducing inefficiency and cost (Bliss, 2009; Zidel, 2006b). The term "*successful initiation*", for the purpose of discussion, implies a continuous and enduring application of Lean principles, tools and techniques within the organisation, over at least 6 months, which employees embrace as a management approach, and which yields positive results for well-defined success indicators.

Literature reviews on the identification and discussion of Critical Success Factors (CSFs) for Lean initiation in health care, particularly in hospitals, are deficient. This manuscript serves to provide a cursory overview of key literature available on CSFs for Lean initiation, both within and external to the health-care sector.

THE SOUTH AFRICAN CONTEXT OF HEALTH CARE MANAGEMENT

Despite the developmental trajectory of health services and the enthusiasm of government leaders for improving health care in South Africa, social science researchers offer intricate explanations for the "failure of the developmental state" in South Africa (Seekings, 2015). In simple terms, Von Holdt (2010) cites in Seekings (2015) five factors that underlie the mismanagement in public sectors such as health:

a) The high turnover of managers in public hospitals, owing to affirmative action policies providing fertile ground for rapid progression up the corporate ladder, as opposed to managers stabilising and focusing on doing their jobs. With as many as one-third of public-sector managers moving jobs each year, instability was created in the journey to improve services in institutions (Naidoo, 2008).
b) Incongruity and contradiction in skills required to perform managerial functions, in the face of employment equity rubrics, provided a game-changing view of productivity in the public sector.
c) Deference and race were more important than competence and skill in managerial roles.
d) A breakdown in work ethic and organisational discipline, with vociferous labour unions and their demands, naturally led to the demise of order and corporate governance in some institutions.
e) Budget mismanagement and extreme resource constraints in the face of increasing demands on the health-care system, and corruption imbroglio amongst certain managers, added more pressure to crumbling institutions.

Given this backdrop, particularly the last factor, it is imperative that a fundamental shift in management philosophy is required in order to create a platform which breeds inspiration, and yields productivity through efficiency.

Recently, the South African Department of Health has embarked on a journey of implementing National Health Insurance (NHI) in a drive towards universal health coverage of the population. This is being carried out by creating a functional district health system (DHS) as a platform for primary health-care (PHC) re-engineering, strengthening and delivery, as well as reorientation of the health system toward "prevention is better than cure" (Gilson *et al.*, 2014; KZN Department of Health, 2018a; National Department of Health, 2011, 2013, 2014).

The strategic goals of health care in South Africa can be summarised by the long-term "Vision 2030" and priorities outlined in the National Developmental Plan, and the National Department of Health's medium-term strategic goals 2014-2019 (Table 1). A significant component of these cross-cutting ambitions involves operations and quality management, namely health systems reforms and strengthening, quality improvement, and financial and information systems management. However, the answers to how management systems can be overhauled are left wanting.

With the need for overhauling the health-systems-delivery platform in KwaZulu-Natal (KZN), being the second-most populous province in South Africa, the realization of the strategic priorities in its health transformation agenda has become ever more exigent (KZN Department of Health, 2018a). Homing in on examples of operations or systems-management priorities reflected in the KZN Department of Health's 2018-2019 Annual Performance Plan (Table 2), it is clear that a considerable portion of the KZN Department of Health priorities are overtly in need of adroit managers with a sound management approach, to be successfully addressed.

Table 1: National Development Plan Vision 2030, Priorities 2030, and National Department of Health Goals 2014-2019

NDP Goals 2030	NDP Priorities 2030	NDoH Strategic Goals 2014- 2019
Average male and female life expectancy at birth increased to 70 years	a. Address the social determinants that affect health and diseases d. Prevent and reduce the disease burden and promote health	Prevent disease and reduce its burden, and promote health;
Tuberculosis (TB) prevention and cure progressively improved;		
Maternal, infant and child mortality reduced		
Prevalence of Non-Communicable Diseases reduced		
Injury, accidents and violence reduced by 50% from 2010 levels		
Health systems reforms completed	b. Strengthen the health system	Improve health facility planning by implementing norms and standards;
		Improve financial management by improving capacity, contract management, revenue collection and supply chain management reforms;
	c. Improve health information systems	Develop an efficient health management information system for improved decision making;
	h. Improve quality by using evidence	Improve the quality of care by setting and monitoring national norms and standards, improving system for user feedback, increasing safety in health care, and by improving clinical governance
Primary health care teams deployed to provide care to families and communities		Re-engineer primary healthcare by: increasing the number of ward based outreach teams, contracting general practitioners, and district specialist teams; and expanding school health services;
Universal health coverage achieved	e. Financing universal healthcare coverage	Make progress towards universal health coverage through the development of the National Health Insurance scheme, and improve the readiness of health facilities for its implementation;
Posts filled with skilled, committed and competent individuals	f. Improve human resources in the health sector g. Review management positions and appointments and strengthen accountability mechanisms	Improve human resources for health by ensuring adequate training and accountability measures.

Source: National Department of Health (2014).

Table 2: Examples of KwaZulu-Natal Department of Health Operations or Systems Management-related Priorities 2018-2019

KZN Department of Health Priorities	**Key focus areas and interventions (Operations or Systems Management-related items)**
Effective budget management	• Ensure cost containment and efficiency measures are in place and strictly adhered to
Improve patient waiting times	• Phased implementation of Centralised Chronic Medicines Dispensing and Distribution
Improve audit outcomes	• Supply Chain, Asset & Contract Management Strategy • Internal control and rigorous implementation & monitoring of the Audit Improvement Plan • Performance Information Improvement Plan • Financial management including Cost Containment Plan • Implement & monitor reviewed decentralised SCM, Financial and Human Resource delegations
Improve HR management	• Strengthen performance management & development
Improve management of performance information	• Implement strategy to improve record management • Rollout of web-based District Health Information System • Improve review and use of data at facility, sub-district & district level and improve the feedback system • Implement performance information management strategy • Implement the approved IT strategy including increasing broadband access at facility level
Manage finalisation and implementation of the integrated Turn-Around Plan	• Finalise the integrated Turn-Around Plan and manage and monitor implementation at all levels • Establish enabling environment for service delivery
Improve access, inequities, quality and efficiencies of District Hospitals	• Finalise the District Hospital Efficiency Study and use findings to inform the District Hospital Rationalisation Plan • Rationalisation including: Review referral systems & pathways; Redefine roles of Family Physicians in District Health System; and Complexing of identified facilities to ensure optimal utilisation of resources • Scale up implementation of National Core Standards • Strengthen Clinical Governance in all facilities
Implement strategy to reduce Medico-legal risks	• Finalise and implement the approved Medico-Legal Strategy & Implementation Plan
Reduce maternal mortality	• Improve safety at caesarean section delivery sites • Improve quality of antenatal, intrapartum and postnatal care
Reduce under 5 mortality	• Strengthen notification of deaths of children in hospital • Improve clinical audits of deaths • Strengthen Paediatric outreach through the District Clinical Specialist Teams
Improve storage medicine capacity at facilities	• Implement Direct Delivery System to facilities • Implement Cross Docking
Prevent medicine stock out, theft and abuse and wastage	• Automation of Expired Medication Alerts to improve stock management

Source: KZN Department of Health (2018a).

Again, the question of how operations or systems-related priorities are tackled in a systematic approach is unanswered and only marginally described. In fact, there is no mention at all in the above plans of any management approach or system that could be adopted to operationalise the priorities, once again leaving elaborately designed documents floating without a management tactic or approach to form the backbone of implementation of such.

THE WORLDWIDE CONTEXT OF CRITICAL SUCCESS FACTORS FOR LEAN

Critical success factors can be defined as “the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization” (Rockart, 1979: 85). It has been posited that research results show both successful and unsuccessful Lean implementation, indicating that critical success factors for its initiation have to be recognised (Kundu and Manohar, 2012). Several studies, mainly in the manufacturing industry, which identify the critical success factors for Lean have been conducted of recent years (Table 3). Although the origin of Lean lies in the manufacturing arena, its application over the years has proliferated in the service industries as well.

Table 3: Research Landscape showing Identified Critical Success Factors

Context and researchers	Critical success factors (extracted from literature review)
CSFs relevant to measuring the degree of success of lean implementation in Information Technology support services (Kundu & Manohar, 2012)	Management leadership; Management support; Top management commitment; Organizational culture; Communication; Training and skill building; Financial Capability; Measurement framework
Implementation of Lean Manufacturing within SMEs (P. Achanga, Shehab, Roy, & Nelder, 2006)	Leadership and Management, Financial Capability, Skills and Expertise and Organizational Culture
Enablers and inhibitors during the implementation of Lean in a Mexican Public service organization (Sua´rez-Barraza & Ramis-Pujol, 2010)	Commitment to and wish for improvement; Clear resolve to improve; Focus on the simple and practical; Active leadership Outcome or stakeholder-oriented service; Holistic and transversal thinking; Establishing a system for measuring service process performance; Effective implementation of best Human Resource Management practices
Success factors identified during two Lean implementation projects within the same company: a global manufacturer of food processing machines and equipment (Scherrer-Rathje, Boyle, & Deflorin, 2009)	Management commitment to, and involvement in, the lean effort; Employee autonomy to make decisions regarding business process changes; Information transparency of Lean goals Evidence of initial performance improvements and long-term sustainability of Lean efforts
A secondary review of research literature of key factors of success in the management of the Synchronized Production System (SPS) implementation process (Skrudupaite & Jucevicius, 2011)	Business plan and vision; top-management support (including funding); project management (including project champion and teamwork and composition); change management, organizational culture; effective communication, education and training, knowledge transfer, knowledge management (including skills and expertise); organizational structure; monitoring and evaluation of performance: performance measurements
Critical success factors within SMEs implementing lean (Kumar, Antony, & Douglas, 2009)	Management involvement and commitment; Communication; Link quality improvement to employee; Culture change; Education and training; Link quality improvement to customer; Project selection; Link quality improvement to business; Link quality improvement to supplier; Project management skill; Organization infrastructure; Vision and plan; Information Technology and innovation.
Ten critical success factors for software industries from a pilot study (Antony & Fergusson, 2004)	Leadership engagement and uncompromising commitment of top management, supporting OI, cultural change, Lean training, linking Lean to business strategy, accountability, customer involvement, understanding of Lean methodology, project management, project prioritization, and selection
Four essentials for successful implementation of a Lean programme (Mefford, 2009)	Belief in the new program that it will work; Commitment for implementing it from managers; Involvement of the whole organization – employees, resources; Patience and long-term view for the results

Source: (Achanga *et al.*, 2006; Antony and Fergusson, 2004; Kumar *et al.*, 2009; Kundu and Manohar, 2012; Mefford, 2009; Scherrer-Rathje *et al.*, 2009; Skrudupaite and Jucevicius, 2011; Sua´rez-Barraza and Ramis-Pujol, 2010).

In the Information Technology (IT) sector, Sua´rez-Barraza & Ramis-Pujol (2010:388-410) identified enablers and inhibitors of Lean in a public service organisation. These enablers, regarded as CSFs for Lean implementation, include: commitment to and wish for improvement; clear resolve to improve; focus on the simple and practical; active leadership; holistic and transversal thinking; service outcome/customer/stakeholder-oriented; establishing a system for measuring service-process performance and effective implementation of best human-resource management practices (Kundu and Manohar, 2012). Inhibitors such as having a bureaucratic organisational structure, and resistance to change, are identified as having the opposite effect of the CSFs.

Similar to Sua´rez-Barraza & Ramis-Pujol's (2010:388-410) inclusion of an active leadership stance and the clarity of goals, six lessons for successful Lean implementation in IT organisations have been described (Scherrer-Rathje *et al.*, 2009): Accordingly, Lean will not succeed without "visible management commitment; develop formal mechanisms to encourage and enable autonomy; openly disclose mid- to long-term lean goals; ensure mechanisms are in place for the long-term sustainability of lean; communicate lean wins from the outset; continual evaluation during the lean effort is critical".

Kundu and Manohar (2012) propose specific CSFs for the IT-support service industry: "management leadership; management support; top management commitment; organizational culture; communication; training and skill building; financial capability and a measurement framework". They claim that they identified the factors in a "holistic, integrative and comprehensive manner" which are more suitable to IT-support service organisations than the manufacturing sector (Kundu and Manohar, 2012). In recognition of the fact that this proposition is pitched at organisations falling within the services sector, these CSFs could be more useful for Lean implementation in the health-care sector than those proposed for the manufacturing industry.

For various manufacturing organisations, it appears that clear organisational goals, values and vision and communication thereof, emphasis on leadership and commitment, and resource capabilities are acknowledged as common CSFs for Lean (Czabke, Hansen and Doolen, 2008; Mefford, 2009; Pedersen and Huniche, 2011). These are generic concepts which are similar to the factors recognised previously.

A secondary review of research literature of key success factors in the management of the synchronized production system (SPS) implementation process revealed the following factors (Skrudupaite and Jucevicius, 2011):

- Business plan and vision;
- Effective communication, education and training;
- Change management and organisational culture;
- Top-management support including financial support;
- Knowledge transfer and management (including skills and expertise);
- Project management (including project champion, teamwork and composition);
- Organisational structure; and
- Monitoring and evaluation of performance (performance measurements).

These factors reside in distinct but general management domains, without highlighting integration as a recipe for success.

Common to most literature reviewed are the following CSFs or Lean enablers: management or leadership commitment; transparency and communicating a clear vision with a long-term plan to succeed, recognising organisational culture and change management, and an integration of organisational resources. By and large, these CSFs are emphasised in nearly all management teachings as general management practices or principles fundamental to the success of any business. Of note in the literature reviewed is the lack of explanation on how to utilise or apply these CSFs when embarking on a journey of Lean implementation.

THE HEALTH CARE CONTEXT OF CRITICAL SUCCESS FACTORS FOR LEAN

In the health sector, there is a dearth of studies, especially in South Africa, which uncover critical success factors for Lean initiation. Some researchers merely describe the challenges of and barriers to Lean implementation in the health sector, but the converse does not necessarily translate to critical success factors.

Some Lean implementation challenges in the health sector include: variability of processes and patient flow; a lack of understanding of lean; poor communication and leadership; difficulty in defining waste, and difficulty in defining value from patient's perspective (Faull and Booysen, 2007; Grove *et al.*, 2010; Naidoo, 2013).

It is further described that empirical literature on "evidence *how* Lean implementation is operationalised in health care, besides a few isolated case studies that often describe a successful, but isolated project", is lacking (Burgess and Radnor, 2013). However, it has been discovered that there are striking similarities in the systemic application of Lean in three settings, namely, the US (Bohmer and Ferlins, 2006), Australia (Ben-Tovim *et al.*, 2007), and the UK (Bowerman and Fillingham, 2007): starting from a crisis standpoint; leadership commitment; commitment to organisational change; use of rapid improvement events or *kaizen* events; structured problem identification and solving skills; training of staff on Lean; and rigorous application of Lean tools. Organisational readiness factors such as understanding of the system view, patient perception, use of information, and engaging the employees are also cited as key variables in preparing for Lean implementation (Radnor, 2011).

In an influential study involving a systematic review of thirty-three articles on PubMed, Web of Science, and Business Source Premier dating from January 1998 to February 2008, four different change mechanisms were described for the positive results yielded through Lean, and outlined in all thirty-three articles: understanding processes;

planning and organising for effectiveness and efficiency; increasing awareness and process reliability; and collaborating amongst staff to systematically solve problems (Mazzocato *et al.*, 2010).

Noori (2015) employed structural equation modelling (SEM) in his study focusing particularly on the CSFs for Lean implementation in the hospital environment in Iran. His review of literature revealed that there was lack of assessment of success factors and lean success within hospitals (Noori, 2015). The hypothesised model of CSFs for SEM analysis included five constructs (Figure 1): strategic orientation, organisational culture, management systems, implementation process, and implementation team. Structural equation modelling showed high correlation between Lean success and management systems, but moderate correlation with the other CSFs (Noori, 2015). The findings of the study confirmed some of the CSFs surveyed in the literature, but still does not provide the "how" to systematically enact them.

Figure 1: Five hypothesized CSFs for Lean implementation in hospitals in Iran
Source: Noori (2015).

A detailed literature review of CSFs for Lean application in health-care organisations showed indistinctly from most literature surveys reflected in this manuscript that leadership, organisational culture, communication, training, measurement and reward systems, are important readiness factors for Lean roll-out (Al-Balushi *et al.*, 2014). The authors, however, further noted that these can be difficult for health-care settings, which are often complex in nature (Al-Balushi *et al.*, 2014).

A study in the Gauteng province of South Africa investigated the success of Lean in public hospitals. The gist of this could not be described more aptly as follows:

> *"The research exposed Lean as appropriate in multifaceted knowledge work environment comparable to assembly-line manufacturing. Executed decorously, Lean transmutes the manner organizations behave and initiate a voracious pursuit for improvement. The paper delineates Lean philosophies as deliberate, signifying the vital vibrancy of Lean. The fundamentals isolated were, postures on continuous improvement, value creation, and unity of purpose, reverence for employees, visual tracking, and malleable procedure. The mechanisms encompass a structure or exemplar for gauging, assessing, analyzing and improving the hospitals"* (Kruger, 2014: 79).

In a ground-breaking study conducted in a tertiary hospital in Cape Town, South Africa, the researcher identified 13 success factors (Table 4) for Lean implementation, defined as enablers (Brey, 2011). The theory emerging from the study demonstrates the interrelation between "Lean readiness" as an antecedent for Lean implementation and the hard facts in identifying problems and developing solutions. The researcher posits that high levels of Lean readiness (constituting "disposition of staff to participate" and "creation of safe spaces affects willingness to engage") will result in good outcomes of Lean (Brey, 2011).

Table 4: List of Enablers of Lean Implementation in a Hospital Setting

Changes made are based on real facts versus gut feel
Tasks have clear specification of who does what, when and how
Focused problem solving to find root causes
Actively monitoring interventions
Recognising the need for change
Structure plan for improvements (using Plan, Do, Check, Act or PDCA)
Participation by staff in improvement initiatives
Spirit of working towards one goal
Many small wins were achieved during the project
Staff ideas are recognised and acknowledged
Staff are comfortable giving their input
There are regular meetings focused on improvement
Discussions are open with a positive vibe and good communication

Source: Brey (2011).

Of the literature appraised, at least two studies which attempted to identify CSFs or readiness factors for Lean implementation were conducted in South Africa. Most of the available and reviewed literature demonstrated various CSFs, whether statistically tested or not, for Lean implementation in the health-care sector, and most of which shared traits similar to those identified in the non-health-care sectors.

PITFALLS AND GAPS IN EXISTING AND REVIEWED LITERATURE

Although a commendable effort has been made in the available, reviewed literature to identify Lean CSFs or readiness factors in the health-care sector, very little information is available on the deployment and practical application thereof when embarking on a Lean journey, particularly in a hospital setting. One study showed the application of SEM to analyse hypothesised CSFs in a hospital setting; however, the reliability of the data beyond the study sites is uncertain.

Apart from the elaborate descriptions of the challenges and success factors for Lean implementation, one of the key gaps elucidated in the above literature review includes a scantiness of studies in the health-care sector, especially in South Africa. No tools were identified from the reviewed literature that were proposed either for the initiation of Lean, or for the assessing of readiness of health-care institutions for the roll-out thereof. Success factors are merely described and analysed; however, none of the studies propose an initiation tool for Lean in health-care institutions, let alone in Africa.

Another important finding is the vast focus on success factors in non-health-care organisations, possibly because Lean originated from the manufacturing sector. Neither could literature describing the knowledge and experience of health-care workers of Lean in South Africa be found.

CONCLUSION

This manuscript aimed to identify and describe existing literature on CSFs for Lean implementation, whether or not in the health-care sector. Most of the available and reviewed literature describing various CSFs for Lean implementation in the health-care sector demonstrated that the CSFs shared traits similar to those identified in the non-health-care sectors.

LIST OF ABBREVIATIONS

CSF: Critical Success Factor

DHS: District Health System

IT: Information Technology

KZN: KwaZulu-Natal

NHI: National Health Insurance

PHC: Primary Health Care

US: United States

SEM: Structural Equation Modelling

DECLARATIONS

None.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The Humanities and Social Sciences Research Ethics Committee from the University of KwaZulu-Natal provided full approval for the protocol reference number: HSS/0031/016D.

CONSENT FOR PUBLICATION

Consent for publication of results was obtained from the KwaZulu-Natal Provincial Department of Health.

COMPETING INTERESTS

The author declares that he has no competing interests.

AUTHORS' CONTRIBUTIONS

This manuscript is based on a PhD study. LN made substantial contributions to the design, acquisition of data, as well as the analysis and interpretation of data. LN authored the manuscript.

The author participated sufficiently in the work to take public responsibility for the content; and agreed to be accountable for all aspects of the work in ensuring that questions relating to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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4.3 Conclusion

This chapter and corresponding article provide an overview of existing literature on CSFs for Lean implementation within and external to the health-care sector. Most of the available and reviewed literature describing various CSFs for Lean implementation in the health-care sector demonstrated that the CSFs shared traits similar to those identified in the non-health-care sectors.

Although a laudable effort has been made in existing literature to identify Lean CSFs or readiness factors in the health care sector, very little information is available on the deployment and practical application thereof when embarking on a Lean journey, particularly in a hospital setting.

Apart from the elaborate descriptions of the challenges and success factors for Lean implementation, one of the gaps elucidated in the above literature review includes a deficiency of studies in the health-care sector, especially in South Africa. No tools were identified from the reviewed literature in South Africa that were proposed either for the initiation of Lean or for assessing the readiness of health-care institutions for the roll-out thereof. Success factors are merely described and analysed, but none of the studies propose an initiation tool for Lean in South African health-care institutions.

Another important conclusion is the vast focus on success factors in non-health care organisations. No literature describing the knowledge and experience of health-care workers of Lean in South Africa could be found.

It is against the backdrop provided by this article that the study purpose and objectives, as described in Chapter 1, have been contextualised, thus creating a strong justification for the research in order to add to the Lean body of knowledge.

The next chapter, corresponding to Objective 1 of the study, examines the knowledge, experience and perceptions of Lean amongst senior health-care managers in KZN public hospitals.

5. CHAPTER FIVE: ARTICLE 2: KNOWLEDGE AND EXPERIENCE OF LEAN AMONGST SENIOR HEALTH-CARE MANAGERS IN PUBLIC HOSPITALS IN KWAZULU-NATAL

5.1 Introduction

This chapter, which represents the article entitled "*Knowledge and experience of Lean amongst senior health-care managers in selected public hospitals in KwaZulu-Natal, South Africa*", examines the baseline knowledge of and experience with Lean of health-care managers in KZN public hospitals. Fulfilling Objective 1 of the research, this chapter and article provide a point of departure for determining the level at which to pitch any future Lean adoption or implementation strategies or tools, by providing the results of a baseline survey of the current knowledge and experience of senior health-care managers in the public sector. A comprehensive understanding of KZN public hospital managers' existing Lean know-how, skill set, attitude. and zeal towards Lean adoption is crucial for developing any means of rolling out Lean on a large scale.

In April 2019, this article was submitted to SPOUDAI Journal of Economics and Business (Reference #6410) and has been accepted on 21 November 2019 for publication (Annexure J).

5.2 Article submitted to and accepted by journal for publication

Abstract

Background

Lean is a recognised management approach employed to identify and successfully resolve operational problems while reducing inefficiency and cost (Bliss, 2009; Zidel, 2006b). There is a pressing need for quality improvement, and the impetus is there to adopt Lean as a systematic management approach in a crisis-ridden health-care sector in South Africa (Gilson and Daire, 2011). It is therefore an opportune time to investigate the baseline level of knowledge and experience of Lean amongst senior health-care managers in public hospitals of KwaZulu-Natal.

Methods

The research was centred on a positivist paradigm (involving quantitative methods); and took the form of an observational, descriptive study set in KwaZulu-Natal (KZN), South Africa. Simple random sampling was applied to select the participants from various subgroups of senior managers in 73 KZN public hospitals. The sample size was 218, from a population of approximately 500 senior managers located in 73 hospitals, with a response rate of 96.8% (n=211). A self-administered, semi-structured questionnaire was used. Statistical analyses were conducted using the SPSS® software package.

Results

A significant 72% (n=152) of managers indicated that they had not previously heard of Lean ($p<0.0005$). The results indicated scant knowledge of Lean ($t\ (56) = -7.353$; $p<0.0005$), particularly amongst managers with less than 10 years of management experience. A noteworthy 44.1% (n=26) of managers who knew of Lean reported possessing no practical experience thereof. On the contrary, 91.9% (n=182) of all participants indicated that they would be interested in learning more about Lean ($p<0.0005$). They also strongly felt that there was an opportunity for adopting Lean practices ($t=-12.800$; $df=188$; $p<0.0005$); and that Lean could possibly improve the operational performance of their hospitals ($t=-12.758$; $df=188$; $p<0.0005$).

Conclusions

The level of knowledge of and practical experience with Lean and its tools and techniques is low amongst senior health-care managers in the 73 KZN public hospitals. The organisation's overall current approach to Lean in terms of Petterson's model lies within the 'Toolbox Lean' quadrant, suggesting that the organisation would benefit from critical success factors for Lean initiation to take the degree of Lean industriousness to 'Lean thinking' (Pettersen, 2009). Significant enthusiasm for Lean application exists amongst senior managers, Such managers would be an ideal target for training on Lean and being involved in the implementation of Lean in KZN public hospitals.

Introduction

Recent emphasis has been placed on health system strengthening for improving quality of health care. Admittedly, however, these quality improvement initiatives have been "uncoordinated and minimally monitored", according to the Office of Health Standards Compliance. The aforementioned is an independent body established in South Africa to regulate the quality of services in the public health sector (Moleko *et al.*, 2014; SARRAH, 2013; World Health Organisation, 2007b).

Lean thinking, or "Lean", is a well-recognised management approach employed to identify and successfully resolve operational problems, providing better health care to patients, while reducing inefficiency and cost (Bliss, 2009; Zidel, 2006b). There is a need for quality improvement with a view to adopting Lean as a systematic management approach in a crisis-ridden health-care sector in South Africa (Gilson and Daire, 2011). Thus, it is opportune to investigate the baseline knowledge and experience of Lean amongst senior health-care managers in the country's public hospitals.

Background

South African public health-care facilities face a variety of operational management issues, partly owing to two key groups of limitations. One of these, cited in the 2008 'Road Map' report of the Development Bank of South Africa (DBSA) and by Gilson and Daire (2011), is related to the challenges in policy implementation (Development Bank of Southern Africa, 2008; Gilson and Daire, 2011). Certain new policies have caused more barriers to health care, defeated equity promotion, and undermined quality of care and health provider motivation (Gilson and Daire, 2011). The other significant limitation concerns the organisational structures and culture entrenched in the public health-care system (Gilson and Daire, 2011).

In order to achieve sustainable improvement in the delivery of health care with limited resources, efforts should be made towards improved health-care management and "doing better with less" (Mayosi and Benatar, 2014). Lean is one such fast-growing approach which uses tools and techniques readily adaptable and suitable for application in public hospitals. However, transforming health-care service delivery, understanding the readiness for change, and conducting a situational analysis, is the second of the four stages of the model for leading change, after determining the desired end state (Figure 1) (Golden, 2006). In addition, in order to determine the level at which to pitch any future Lean adoption or implementation strategies or tools, a baseline survey of the current knowledge and experience of senior health-care managers in the public sector is essential.

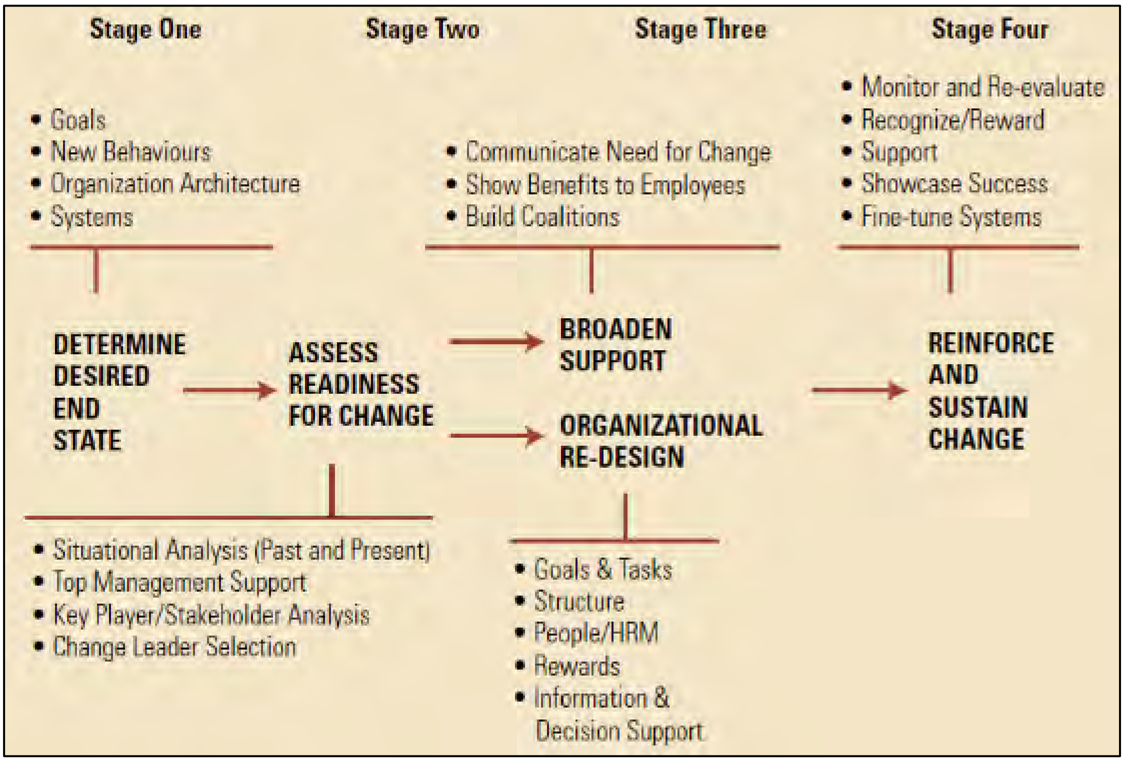

Figure 1: Four stages of leading change.

Source: Golden (2006).

Lean is a recognised management approach employed to identify and successfully resolve operational problems while reducing inefficiency and cost (Bliss, 2009; Zidel, 2006b). The primary focus of Lean is on reducing waste, synchronising flows, and managing variability in (process) flows. In this context, the knowledge and experience thereof amongst public health-care managers is not well understood in South Africa.

Method

As a component of this study conducted in KwaZulu-Natal (KZN), South Africa, primarily aimed at developing a Lean success predictor tool for the initiation of Lean in public hospitals, one of the research objectives was to describe the knowledge and experience of Lean amongst senior health-care managers in public hospitals in the same province. The research was centred on a positivist paradigm, employing quantitative methods, and took the form of an observational, descriptive study.

Study site, target population and sampling

The research was conducted in the province of KZN, South Africa, which is the second-most densely inhabited province of the nine within the country (KZN Department of Health, 2014). KwaZulu-Natal is located in the eastern coastal region of the country. In 2013, the province was home to approximately 10 457 907 citizens, according to mid-year population estimates from Stats SA (KZN Department of Health, 2014). Table 1 demonstrates the total population per health district in KZN. Within the province are 1 Metropole (eThekwini), 10 health districts, 50 municipalities, and 828 municipal wards scattered across an area of 92100 square kilometres (KZN Department of Health, 2014).

Table 1: Total KwaZulu-Natal Population per District based on Stats SA Mid-year Estimates and District Health Information System (DHIS) Data

District	**2011 (census)**	**2012/13 DHIS**	**2013/14 DHIS**	**2014/15 Year 1**	**2015/16 Year 2**	**2016/17 Year 3**
Ugu	722 484	735 778	771 421	796 126	804 326	812 369
Umgungundlovu	1 017 763	1 036 489	1 077 834	1 089 151	1 100 369	1 111 373
Uthukela	668 848	681 154	705 018	712 421	719 759	726 957
Umzinyathi	510 838	520 237	520 604	526 070	531 489	536 804
Amajuba	499 839	509 036	519 890	525 349	530 760	536 068
Zululand	803 575	818 360	867 932	877 045	886 079	894940
Umkhanyakude	625 846	637 362	673 236	680 305	687 312	694 185
Uthungulu	907 519	924 217	986 080	996 434	1 066 697	1 016 763
Ilembe	606 809	617 975	635 026	641 694	648 303	654 786
Harry Gwala	461 419	469 909	516 693	522 118	527 496	532 770
eThekwini	3 442 361	3 505 700	3 511 761	3 548 634	3 585 185	3 621 037
KwaZulu-Natal	**10 267 300**	**10 457 907**	**10 785 397**	**10 898 644**	**11 010 900**	**11 121 009**

Source: KZN Department of Health (2014).

Non-probability, purposive type sampling was used in order to focus the enquiry, based on particular characteristics of targeted senior managers. The target population included 500 senior managers, consisting of the following ranks based at 73 public hospitals across the province (whether or not acting in the position): hospital executive managers, assistant managers, operational or unit managers, and managers of clinical departments.

The planned sample size of senior managers, considering a 5% margin of error and 95% confidence interval, was 218 of a population of 500 senior managers. The response rate was 96.8%, with 211 participants. Simple random sampling was applied to select the participants from the subgroups of senior managers mentioned above.

Data collection

A self-administered, semi-structured questionnaire with mixed categorical, open-ended, and variable Likert-scale questions was used for data collection.

Data analysis

Statistical analyses were carried out using the SPSS® software package. Descriptive statistics, including means and standard deviations, where applicable, were used. The Wilcoxon Signed Ranks test was used to test whether the average value was significantly different from central scores for responses to Likert-scale questions. It was also used in the comparison of the distributions of two variables. The Kruskal Wallis test, Fisher's Exact test and Mann Whitney U test were used, where applicable.

Ethics

Research ethics approval (HSS/0031/016D) was obtained from the Human Social Sciences Research Ethics Committee (HSSREC) at the University of KwaZulu-Natal (UKZN). Permission was also obtained from the KZN Department of Health's Provincial Health Research and Knowledge Management unit (KZ_2016RP31_475) and Deputy Director General for Specialized Services and Clinical Support. Informed consent was obtained from all participants.

Results

Response rate and general characteristics of respondents

A total of 211 of 218 self-administered questionnaire responses were received (96.8% response rate). The main respondents were assistant managers (other than nursing) and supervisors (46.4%), nursing unit or assistant managers (24.6%) and managers of clinical departments (10.4%) (Figure 2).

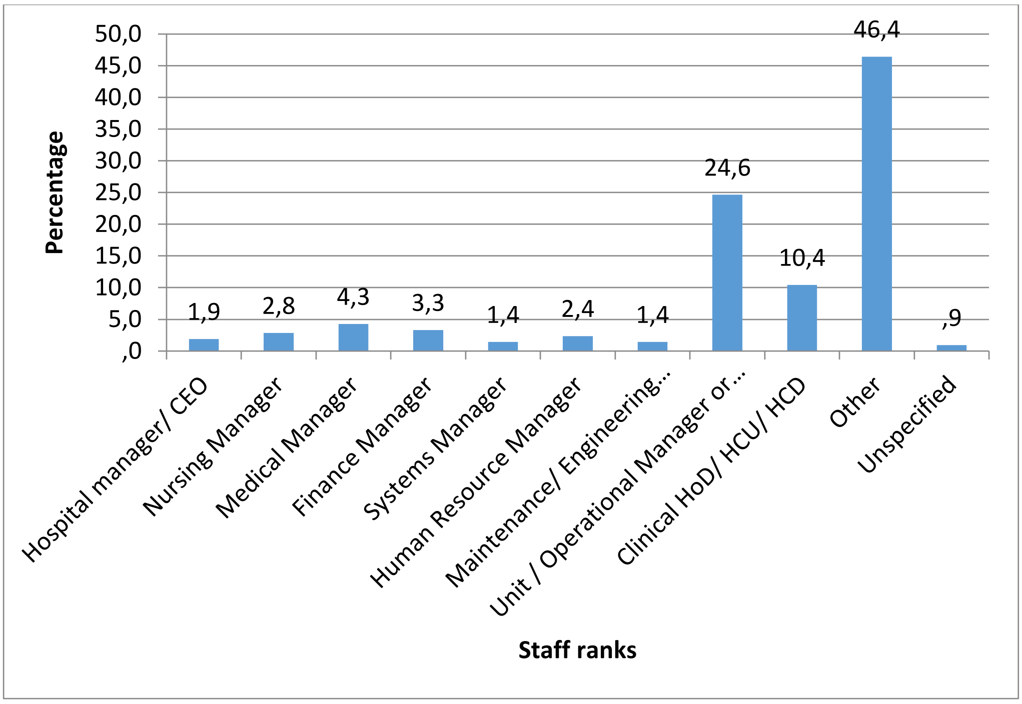

Figure 2: Distribution of respondents' rankings (job titles).

Source: Author developed.

Most of the respondents (43.1%) possessed more than 10 years of management experience, followed by a smaller proportion (25.6%) having 5 to 10 years' management experience (Figure 3). A still smaller proportion (19.0%) possessed 2 to 5 years of management experience.

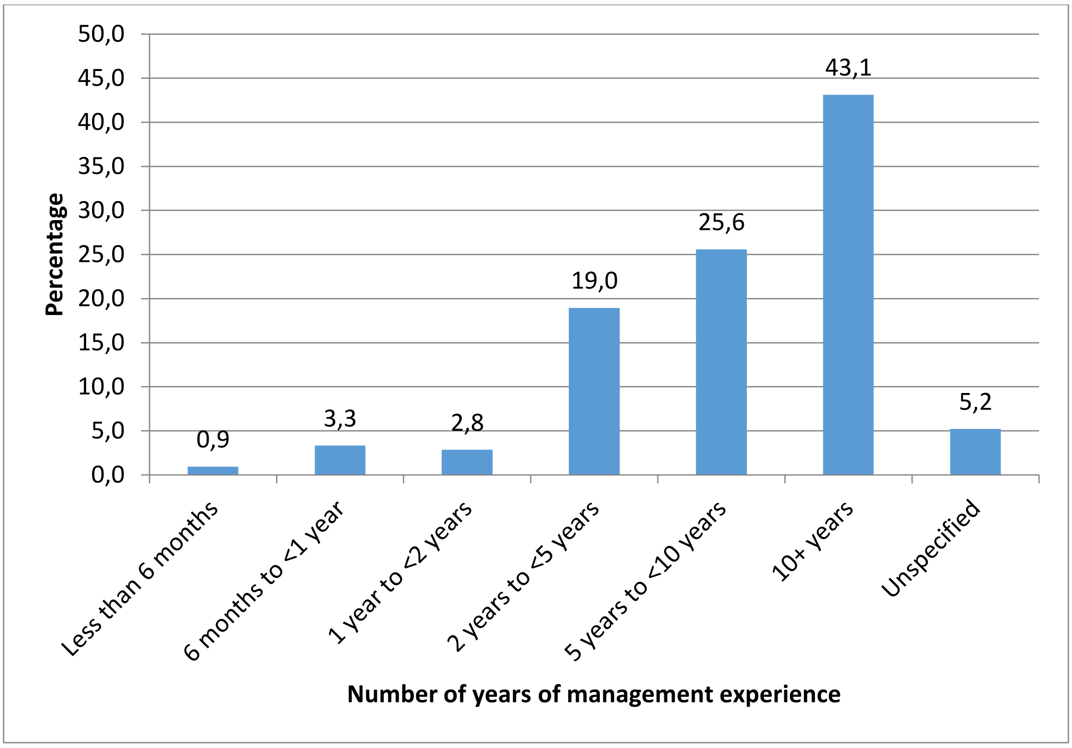

Figure 3: Respondents' management experience in years.

Source: Author developed.

Senior Managers' knowledge of and experience with Lean

A significant 72% (n=152) of managers indicated that they had not previously heard of Lean ($p<0.0005$). The most common medium or platform through which the remaining 28% (n=59) of managers had heard of Lean was an informal setting, or through a colleague or a friend (62.1%) (Figure 4). Other common sources of reading about Lean were per Internet searches or non-academic websites (34.5%) and newspapers, television, pamphlets, or brochures (19%). Relatively few managers had learnt about Lean via a training course, workshop or conference held within (10.3%) or outside (6.9%) the KwaZulu-Natal Department of Health.

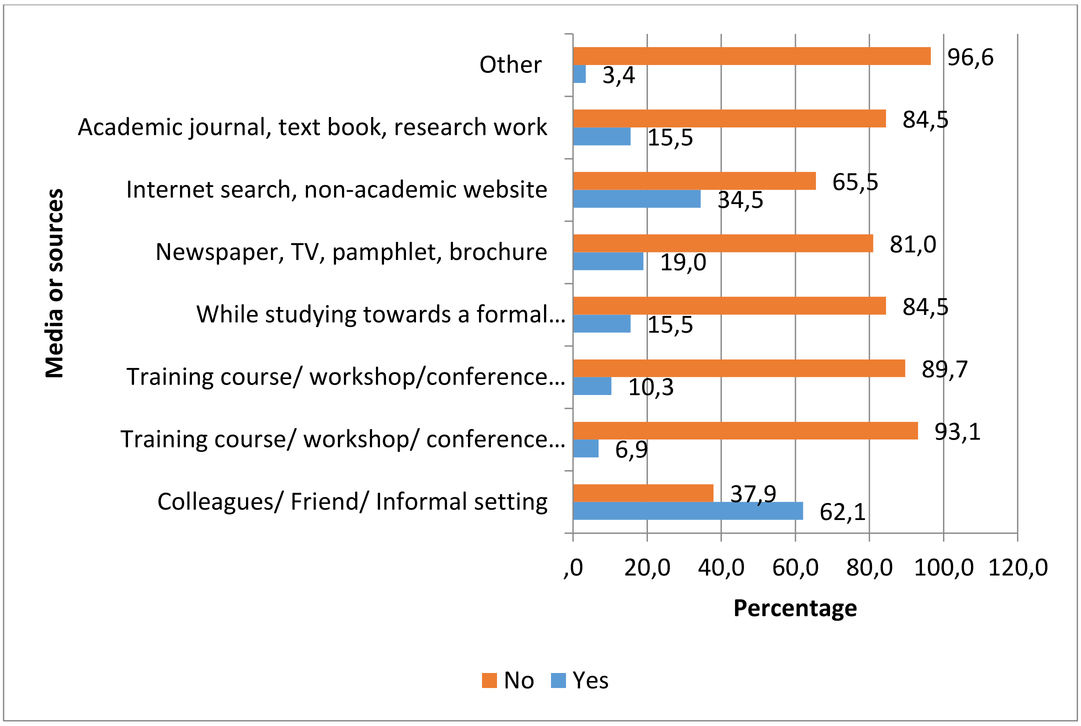

Figure 4: Distribution of sources through which managers have learnt about Lean.
Source: Author developed.

The results also indicate that a significant proportion of managers had not read or learnt about Lean from these sources: training course/workshop/conference held either outside ($p<0.0005$) or within the KZN Department of Health ($p<0.0005$); while studying towards a formal qualification (degree/diploma/certificate) ($p<0.0005$); newspaper, television, pamphlet or brochure ($p<0005$); Internet search or non-academic website ($p=0.025$); and academic journals, text books, or research work ($p<0.0005$).

In terms of managers rating their level of knowledge of Lean on a Likert scale, the average score was significantly lower than a neutral score of '3', thus indicating scant knowledge of Lean ($t\ (56) = -7.353$; $p<0.0005$).

The results also showed that a significant relationship exists between the number of years of senior management experience in the health sector, and participants' having knowledge of Lean prior to the study (Fisher's exact = 12.235; $p=0.019$). A significant number of those with 10 or more years of management experience in the health sector had heard of Lean prior to the study, while a significant number of those with 5 to 10 years of health-sector management experience had not.

Knowledge and use of Lean tools and techniques

Of the 59 senior managers who had certain knowledge of Lean, approximately 62.7% (n=37) indicated that they did not know of any Lean tools and techniques (p=0.067). Of the 37.3% (n=22) who knew about Lean tools and techniques, the most commonly cited Lean tools and techniques were PDCA (15.38%), 5-why (12.82%) and 5-S (12.82%) (Table 2). Managers have indicated no knowledge of andons, *kanbans*, *poka yokes* and *Jidoka*. A recognised concept of Lean (*kaizen*) has been correctly cited by managers who had knowledge thereof, but a number of other concepts or techniques listed, such as Key Performance Indicators (KPIs) and SMART (Specific, Measurable, Achievable, Realistic, Time-bound) goals were incorrectly perceived as specific Lean tools and techniques (Table 2).

Table 2: Frequency Distribution of Lean Tools or Techniques which Managers have Knowledge of.

Lean tool or technique	Frequency of responses	%	Cumulative %
Plan, Do, Check, Act (PDCA)	6	15.38%	15.38%
5-why	5	12.82%	28.21%
5-S	5	12.82%	41.03%
JIT	4	10.26%	51.28%
Value stream maps	3	7.69%	58.97%
A3 chart	3	7.69%	66.67%
Andons/ kanbans	0	0.00%	66.67%
Poka yokes	0	0.00%	66.67%
Jidoka	0	0.00%	66.67%
"Other" (verbatim responses as indicated by managers, thus may reflect perceptions of managers and may not necessarily be Lean tools or techniques)			
Kaizen	4	10.26%	76.92%
Fishbone diagram	2	5.13%	82.05%
Process mapping	1	2.56%	84.62%
Team building	1	2.56%	87.18%
Bottleneck analysis	1	2.56%	89.74%
Root cause analysis	1	2.56%	92.31%
SMART goals	1	2.56%	94.87%
Walkabout	1	2.56%	97.44%
KPIs	1	2.56%	100.00%
TOTAL	**39**	**100.00%**	**100.00%**

Source: Author developed.

In terms of the use of Lean tools and techniques in their jobs, 62.5% (n=35) of the managers who knew of Lean indicated that they had never used the tools (p=0.081). Of the 37.3% (n=22) of managers who were familiar with certain Lean tools and techniques, only a few had indicated that they had used such tools in their jobs. The results (Figure 5) reflect the following Lean tools and techniques as being the top three used by these managers (proportion of managers who have used them are indicated in parentheses): Plan, Do, Check, Act (PDCA) (66.7%), 5-Why (42.9%) and Just-in-Time (JIT) (33.3%).

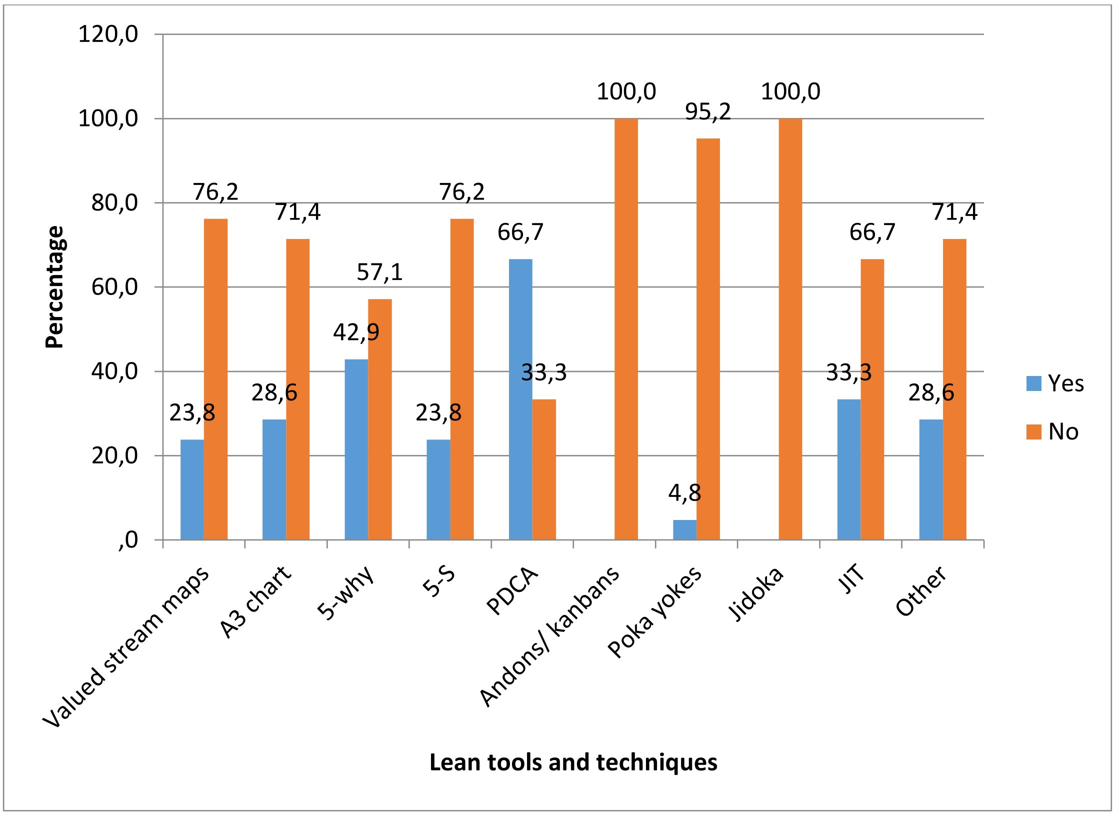

Figure 5: Managers' indication of knowledge of and experience with Lean tools and techniques.

Source: Author developed.

The level of experience of managers with the use of Lean tools and techniques is illustrated in Figure 6. Only 4.8% of responses indicated an “expert” level of skill for the application of PDCA. A fair proportion of managers reported having a mediocre level of skill in the application of PDCA (28.6), 5-Why (23.8%) and JIT (23.8%). A basic level of expertise was reported by a number of managers with regard to the use of PDCA (28.6%), A3-chart (23.8%), 5-Why (19.0%), Value Stream Maps (14.3%), 5-S (9.5%), JIT (9.5%) and *poka yokes* (4.8%).

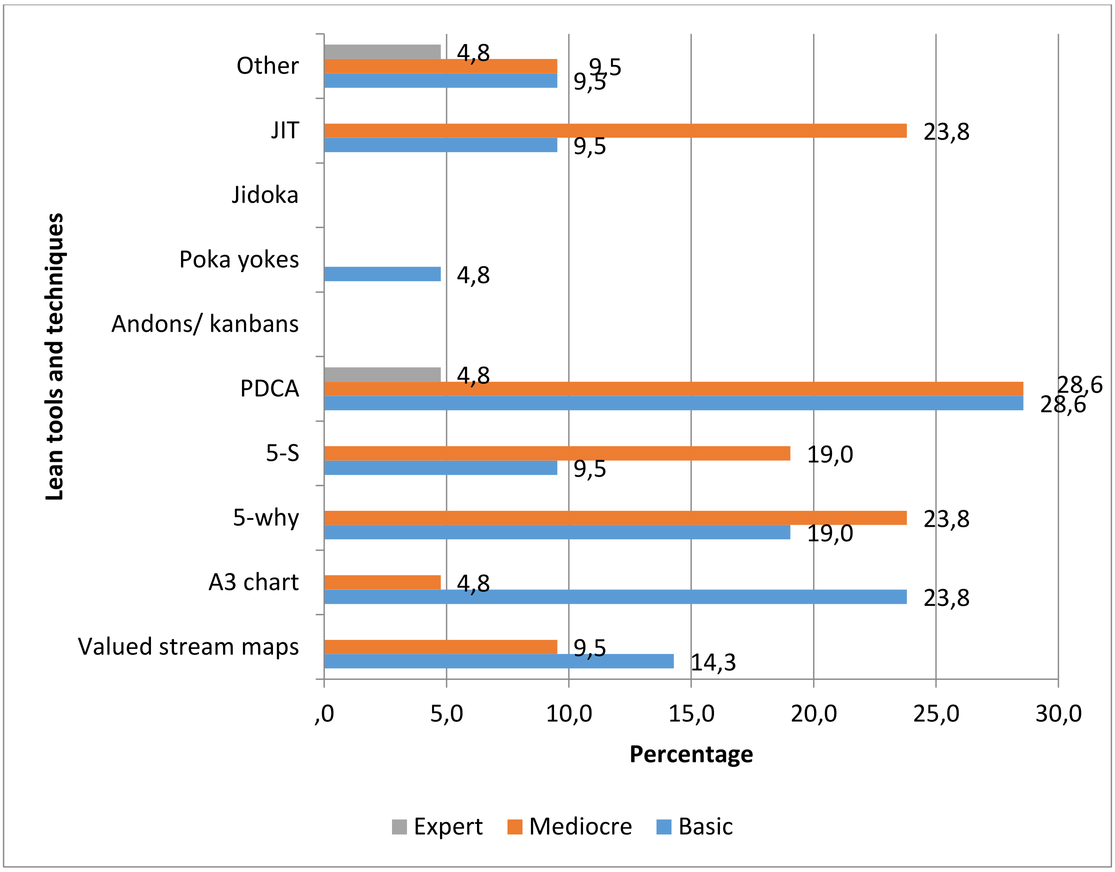

Figure 6: Managers' levels of expertise involving the use of Lean tools and techniques.
Source: Author developed.

Managers' practical experience with Lean

Of the 59 managers who had heard of Lean, a noteworthy 44.1% (n=26) reported having no practical experience with Lean in their career lifetime (Figure 7). Only 10.2% (n=6) reported having at least 5 years of experience with Lean. Specifically, in terms of their careers within the health-care sector, 47.5% (n=28) of managers reported having no experience with Lean. Only 10.2% (n=6) claimed having more than 5 years of Lean experience within the health-care sector.

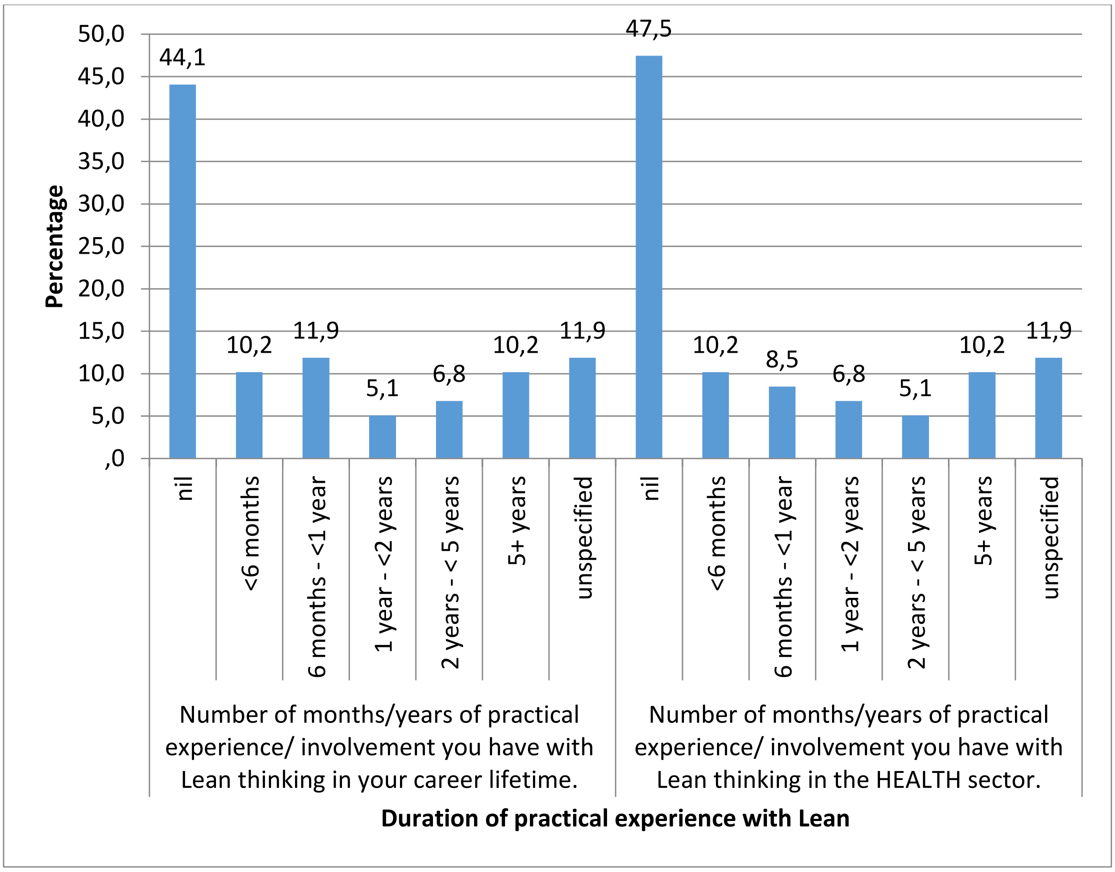

Figure 7: Managers' duration of experience with Lean in their career lifetime.

Source: Author developed.

Prospects for learning and understanding more about Lean

Despite a significant paucity of knowledge and experience of Lean amongst senior health-care managers, 91.9% (n=182) indicated that they would be interested in learning more about Lean ($p<0.0005$). From those who had existing or prior knowledge of Lean, 100% indicated that they would be interested in learning more about Lean.

Managers also strongly felt that there was an opportunity for adopting Lean practices and applying tools and techniques in their hospitals ($t=-12.800$; $df=188$; $p<0.0005$). In addition, the opinion of managers was that Lean could possibly improve the operational or systems performance in their hospitals ($t=-12.758$; $df=188$; $p<0.0005$). There was no significant difference in the average rating across all categories of managers with Lean experience in response to the question "*Do you think that Lean practices could possibly improve the operational/systems performance in your hospital?*" Most managers indicated a "1 = Most definitely" (Table 3).

Table 3: Managers' Responses to a Question regarding the Potential of Lean to improve Operational Performance.

Do you think that Lean practices could possibly improve the operational/systems performance in your hospital? (rate on a scale from 1 to 5 where '1' is "Most definitely" and '5' is "Definitely not")								
Categories of Lean experience in years	**N**	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**		**Minimum rating**	**Maximum rating**
					Lower Bound	**Upper Bound**		
Nil	30	1.57	1.104	0.202	1.15	1.98	1	5
<6 months	6	2.00	1.673	0.683	0.24	3.76	1	5
6 months to <1 year	7	1.14	0.378	0.143	0.79	1.49	1	2
1 year to <2 years	3	1.33	0.577	0.333	-0.10	2.77	1	2
2 years to < 5 years	4	1.75	1.500	0.750	-0.64	4.14	1	4
5+ years	6	1.50	0.837	0.342	0.62	2.38	1	3
Total	56	1.55	1.077	0.144	1.27	1.84	1	5

Source: Author developed.

Discussion

Senior Managers' knowledge of and experience with Lean

The study findings showed that more than two-thirds of senior health-care managers lacked knowledge of Lean. Even the small number of managers who had heard of Lean admitted that their level of knowledge was significantly low ($p<0.0005$). Certain causes may be attributed to concerns relating to the organisational structures and culture entrenched in the public health care system (Gilson and Daire, 2011). Other possible causes include the popular use of informal and non-academic media or sources to read about Lean, corroborated by a large proportion of managers not having had exposure to Lean through formal or academic means such as training, workshops, academic journals or formal study. Additionally, Lean in South Africa is regarded as a relatively new management approach, and the adoption of Lean in the country's health-care sector has been slow since the early 2000s, with only just over 20 health-care institutions having carried out Lean projects from the early 2000s to 2013 (Moleko *et al.*, 2014).

A significant number of managers with at least 10 years' management experience in the health sector had heard of Lean prior to the study. This finding confirms that Lean is relatively new in the public health-care sector in KZN. Those who have been in the sector for shorter periods are less likely to know about Lean. Management support is repeatedly cited in systematic reviews as one of the key facilitators of Lean success, and that experience with Lean enables improvement (Andersen, Røvik and Ingebrigtsen, 2014; de Souza and Pidd, 2011; Kaplan *et al.*, 2010; Vos *et al.*, 2011). The ability of the organisation to capitalise on the Lean experience of these managers and to train the cadres of junior and aspiring managers on Lean will portend the ease of Lean implementation, going forward.

Knowledge of and practical experience with Lean tools and techniques

Almost half of the managers who knew of Lean had had no practical experience with Lean in their career lifetimes. A larger percentage of managers reflect no Lean experience in the health-care sector. Plan, Do, Check, Act (PDCA), 5-Why, 5-S, Just-in-Time (JIT), Value Stream Map and A3 chart were cited as Lean tools and techniques known to and used by a relatively small proportion of managers who knew of Lean. These tools are commonly referred to in literature and teachings of Lean (Burgess and Radnor, 2013; Faull and Booysen, 2007; Fine *et al.*, 2009; Ganti and Ganti, 2004; Hagg *et al.*, 2007; Womack and Miller, 2005; Zidel, 2006b). They are also easy to apply in any project or activity, whether used as stand-alone tools or in combination with others, particularly if one is not practising Lean in the workplace. The tools and techniques considered to be appropriate for the more advanced Lean experience and skills levels, such as *Jidoka*, *kanbans* and andons, were those found to be unfamiliar to managers. These tools and techniques would generally be taught in formal Lean training or through academic resources, and the relative scarcity of managers learning about Lean through these formal platforms substantiates this observation.

Approximately two-thirds of the managers who had heard of Lean had had no practical experience with Lean tools and techniques in their workplaces. The Lean tools and techniques used in the workplaces by the remaining managers emulate those of which they were aware (PDCA, 5-Why and JIT). This supports the need for training senior managers on the common Lean tools and techniques, as the application incidence is uncommon, notably by those who knew of Lean tools and techniques.

Characterising the baseline knowledge and experience of Lean within the organisation

Although Petterson (2009) offers little empirical evidence for the classification of Lean approaches, the researcher posits four distinct ways in which Lean can be implemented in an organisation, based on the degrees of the level of existence (operational or strategic) and organisational orientation (philosophical or practical) (Figure 8).

The bottom left quadrant 1 reflects a Lean approach which uses isolated events (‘Toolbox Lean’ approach) (Burgess and Radnor, 2013). This fragmented approach can be perceived as being potentially destructive to the organisation (Radnor, Holweg and Waring, 2012; Towill and Christopher, 2005; Waldman and Schargel, 2006; Young and McClean, 2008). Quadrant 2 indicates an approach in which the organisation defines its “Leanness” by a superficial application of a few basic Lean tools and techniques. Managers talk about Lean, arbitrarily using certain visible Lean tools and techniques, but not actually applying Lean comprehensively. This fallacy has often led to failed Lean implementation in certain organisations in Western countries (Burgess and Radnor, 2013). The approach reflected in Quadrant 3 is that in which improvements are aimed at reaching certain goals or targets, but the organisation does so in a continuous and strategic manner (“Becoming Lean”). Quadrant 4 describes an approach in which the organisation appears to entrench Lean as a daily practice and make it ‘part of their daily work’ (Lean Thinking) (Corbett, 2007; Hines, Found and Harrison, 2008).

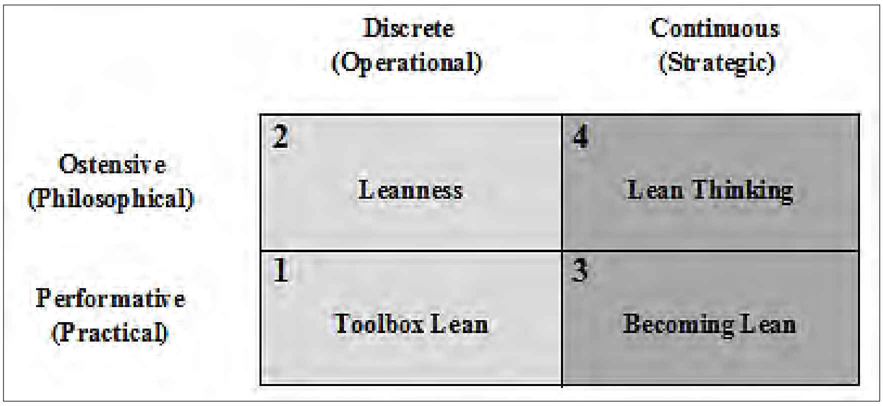

Figure 8: Characterization of approaches to Lean.

Source: (Gilson and Daire, 2011; Pettersen, 2009)

Analysing the relative numbers of KZN public hospitals' senior managers who knew of and applied Lean and its tools and techniques allows us to characterise the organisation's overall current and discernible approach to Lean in terms of Petterson's model (Burgess and Radnor, 2013; Pettersen, 2009). For purposes of clarification, the KZN public hospitals are distant from a Quadrant 4 (Lean Thinking) approach. The findings echo a 'Toolbox Lean' approach, which places the organisation at a basic, entry level of Lean implementation on a small scale.

Prospects for learning and understanding more about Lean

A significant number of senior managers indicated their interest in wanting to learn more about Lean. The optimism of the managers wanting to use Lean to improve operational performance in their hospitals was strongly reflected in the findings. However, a careful approach is required to avoid a failed Lean implementation attempt. This implies the need for better understanding of the critical success factors and an approach to initiating Lean into hospitals.

Conclusions and Recommendations

The level of knowledge of and practical experience with Lean and its tools and techniques is very low amongst senior health-care managers in public hospitals in KZN. The approximate one-third of managers who had heard of Lean admitted that their level of knowledge was significantly low. Managers with more than 10 years of experience in the health-care sector have some pre-existing knowledge of and interest in Lean, suggesting that the organisation should capitalise on such a cadre of enthusiastic managers for Lean implementation.

A number of the Lean tools and techniques which may also be used in any project or activity independent from other Lean methods, such as PDCA, 5-Why, 5-S and A3 chart, are the most commonly known to senior managers in the province. Focus should be placed on enhancing the use of these tools and techniques as part of Lean implementation in the organisation. Other tools and techniques, such as andons and *kanbans*, should be taught through formal Lean training programmes within the organisation.

The organisation's overall current approach to Lean in terms of Petterson's model lies within the 'Toolbox Lean' quadrant (Pettersen, 2009). This places the organisation as having a basic level of Lean implementation with sporadic and infrequent application of Lean tools and techniques on a small scale across the management gamut. This classification suggests that the organisation would benefit from critical success factors for Lean initiation to raise the degree of Lean industriousness to 'Lean thinking' in Petterson's model.

A large majority (91.9%) of managers, more especially those who had heard about Lean previously, indicated that they would be interested in learning more about Lean. Managers also felt strongly that there was an opportunity for adopting Lean practices and applying tools and techniques which could possibly improve the operational performance in their hospitals. Considering this interest in Lean application, the senior managers working in all public hospitals in KZN would be ideally placed for training on Lean, hoping to involve them in the implementation of Lean.

Competing interests

Nil.

Authors' contributions

Logandran Naidoo conducted the research and produced the report. Ziska Fields supervised the research.

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5.3 Conclusion

This chapter corresponds to and meets Objective 1 of the study as it presents KZN public hospital managers' baseline knowledge of and practical experience with Lean. As described within the article, the knowledge of and experience with Lean and its tools and techniques is very low amongst senior health-care managers. Managers with more than 10 years of experience in the health sector have some pre-existing knowledge of and interest with Lean, suggesting that the organisation should capitalise on such a cadre of enthusiastic managers for Lean implementation.

Several Lean tools and techniques which may also be used in any project or activity independent from other Lean methods, such as PDCA, 5-Why, 5S and A3 chart, are the most commonly known to senior managers in the province. Focus should be placed on enhancing the use of these tools and techniques as part of Lean implementation in the organisation, and other tools and techniques, such as andons and *kanbans*, should be taught through formal Lean training programmes within the organisation.

The organisation's overall current approach to Lean in terms of Petterson's model lies within the 'Toolbox Lean' quadrant (Pettersen, 2009). This places the organisation as having a basic level of Lean implementation with sporadic and infrequent application of Lean tools and techniques on a small scale across the management gamut. This classification suggests that the organisation would benefit from having knowledge of critical success factors for Lean initiation to raise the degree of Lean industriousness to 'Lean thinking' in Petterson's model.

A large majority of managers indicated that they would be interested in learning more about Lean. Managers also strongly felt that there was an opportunity for adopting Lean practices and applying tools and techniques which could possibly improve the operational performance in their hospitals. Considering this interest in Lean application, the senior managers working in public hospitals in KZN would be ideally placed for training on Lean, hoping to involve them in the implementation of Lean.

With this significant information on the baseline knowledge, experience, and attitude of managers toward Lean, impetus is provided for identifying the CSFs for Lean initiation, and for developing a Lean readiness assessment tool for the successful roll-out of Lean. Senior health-care managers fervently indicate interest in adopting and learning more about Lean. This underpins the necessity to meet Objectives 2 and 3 of the research (to identify the CSFs for Lean initiation), as detailed in the next chapter and article.

6. CHAPTER SIX: ARTICLE 3: DETERMINING THE CRITICAL SUCCESS FACTORS FOR THE SUCCESSFUL INITIATION OF LEAN THROUGH FACTOR ANALYSIS AND STRUCTURAL EQUATION MODELLING

6.1 Introduction

This chapter corresponds to Objective 2 and Objective 3 of the study which are to identify the key variables for the successful initiation of Lean in public hospitals, and to conduct factor analysis and structural equation modelling (SEM) leading to the identification of CSFs for Lean initiation. The chapter represents the article entitled "*Critical Success Factors for the Successful Initiation of Lean in Public Hospitals in KwaZulu-Natal: A Factor Analysis and Structural Equation Modelling Study*".

Regarded as a fundamental phase of the research, the article reports on the analysis of data and findings of the research, specifically focusing on the reduction of data using exploratory factor analysis (EFA) to identify latent constructs. The use of confirmatory factor analysis (CFA) to determine the reliability and validity of these factors is then explained. SEM fit indices were thereafter applied to assess acceptability of the measurement model. The identified CSFs are then explored further in relation to existing literature.

The article represented in this chapter has been submitted to the Human Resources for Health journal on 13 May 2019, has been accepted on 12 August 2019, and published (Reference number HRHE-D-18-00059R3) (Annexure K).

6.2 Article published in Human Resources for Health Journal

Abstract

Background

Lean thinking is one of several operations-management techniques which have yet to be fully embraced in the South African health-care sector. In most health-care managers' service-delivery mandates, *what* needs to be done might be known, but it is *how* it should be done which might be alien to most managers. In order to recognise the "*how*", one needs to know the critical success factors for Lean initiation.

Methods

The research took the form of an observational descriptive study with quantitative methods. The objectives were to identify the key variables for the successful initiation of Lean; and then to conduct factor analysis and structural equation modelling (SEM) on these variables, leading to the identification of CSFs for Lean initiation. Simple random sampling was applied to select the participants from various subgroups of 500 senior managers across 73 KwaZulu-Natal (KZN) public hospitals. The sample size was 218, with a response rate of 96.8% (n=211). For the purpose of identifying key variables for the successful initiation of Lean and then of conducting factor analysis and SEM on these variables, a self-administered, structured questionnaire was used. Data were reduced using exploratory factor analysis (EFA) to identify latent constructs. Confirmatory factor analysis (CFA) was used to determine the reliability and validity of these factors. Structural equation modelling (SEM) fit indices were then applied to assess acceptability of the measurement model.

Results

Certain variables were eliminated during EFA if they cross-loaded onto more than one factor, since this caused discriminant validity problems. In addition, if variables loaded weakly onto a factor, they were not retained. Three critical success factors (CSFs) were identified in this study: Strategic leadership and organisational attitude; Integration of Lean elements, tools and techniques; and Basic stability in operational processes. All reliability and validity conditions have been met (RMSEA = 0.085; CFI = 0.956 and χ^2 / df = 2.513), consequently rendering the model reliable and valid.

Conclusion

None of the three CSFs can be viewed in isolation, as they all have significance at different dimensions of capability within the organisation. The use of these CSFs and the context, content, application, and outcome of Lean should be viewed in light of the organisation's strategic, technical, structural, and cultural environment. Further research in the effectiveness of these CSFs for the roll-out of Lean in South African hospitals would be of benefit to the Lean body of knowledge.

Introduction

The volatile environment for health-care delivery in South Africa, owing to its quadruple burden of communicable, non-communicable, perinatal and maternal, and injury-related disorders with generally poor health outcomes, compels health-care managers to adopt contemporary management approaches shown to be effective in resource-constrained environments (Coovadia *et al.*, 2009; Mayosi and Benatar, 2014; Whiteside, 2014). Lean thinking is a philosophy involving proven operations practices and techniques that improve the quality and efficiency of production and service delivery by enhancing operational flow and diminishing wasteful activity within an organisation (Zidel, 2006b). However, the question of which critical success factors will predict the success of Lean initiation in public hospitals remains unanswered and receives little attention in the literature describing the South African health-care context.

Background

Lean thinking is one of several operations-management techniques which have yet to be fully embraced in the South African health-care arena (Kruger, 2014; Moleko *et al.*, 2014; Mutingi, Monageng and Mbohwa, 2015). The primary focus of Lean is on reducing waste, synchronising flows, and managing variability in (process) flows (Casey, 2007). Lean methodology comprises five fundamental tenets (Womack and Jones, 1996; Zidel, 2006a):

- *To specify what is of value* to the end-user (the patient);
- *To identify the value stream* in a workflow process;
- *To make the value stream flow* by re-engineering process steps and eliminating bottlenecks;
- *To create pull* down the value-stream which signals when upstream activities can begin; and
- *To pursue perfection* through continuous improvement.

Lean classifies activities in a value stream into three categories: (1) value-added work; (2) type 1 non-value-added work, which is necessary, but does not add value from the standpoint of the patient; and (3) type 2 non-value-added work (waste or "*muda*") which does not add any value to the patient from any perspective and should therefore be eliminated (Zidel, 2006b).

Lean has been revolutionising manufacturing and service industries globally for many years and is endorsed as "creat[ing] a balance between quality and finance by developing the most efficient and effective method of providing value to the customer" (Zidel, 2006b). Faull posits that the application of Lean to health care has begun in earnest, mainly in the USA, United Kingdom, and Australia (Faull and Booysen, 2007). However, the current application of Lean in Southern African health care lacks coherence, despite its increasing prevalence in health institutions (Costello and Osborne, 2005; Moleko *et al.*, 2014; Mutingi *et al.*, 2015).

Substantial resource constraints in the face of increasing demands on the health-care system are cited as important factors underlying mismanagement in public sectors such as health (Seekings, 2015). In order to sustainably recuperate the delivery of health care in the context of the current local challenges of limited resources and poor prospects for economic growth, efforts must be made to create an improved health-care management based on a philosophy of "doing better with less" (Mayosi and Benatar, 2014). It is therefore imperative that a fundamental shift in management philosophy be established to create a platform that nurtures inspiration and encourages productivity through efficiency. In most health-care managers' service delivery mandates, *what* needs to be done may be known, but *how* it should be done remains alien to most managers. To recognise the "*how*", the critical success factors for Lean initiation must be acknowledged and emphasised.

Critical success factors (CSFs) can be defined as "the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organisation" (Rockart, 1979: 85). It has been posited that research results show both successful and unsuccessful Lean implementation, indicating that CSFs for its initiation must be recognised (Kundu and Manohar, 2012). Further observations reveal that empirical literature to "evidence *how* Lean implementation is operationalised in healthcare over and above a few isolated case studies that often describe a successful, but isolated project" is lacking (Burgess and Radnor, 2013).

International studies have shown that there are striking similarities in the systemic application of Lean in three settings; namely, the USA, Australia, and the United Kingdom (Ben-Tovim *et al.*, 2007; Bohmer and Ferlins, 2006; Bowerman and Fillingham, 2007). These similarities include: starting from a crisis standpoint; leadership commitment; commitment to organisational change; the use of rapid improvement events or *kaizen* events; structured problem identification and solving skills; training of staff on Lean; and the rigorous application of Lean tools. Organisational readiness factors such as a clear understanding of the system view, patient perception, the application of information, and engaging employees, are also cited as key variables for preparing for Lean implementation (Radnor, 2011).

In the South African health-care sector, however, there is a paucity of research on CSFs for Lean initiation. Some researchers merely describe the challenges and barriers of Lean implementation in the South African health sector; for example, the variability of processes and patient flow, a lack of understanding of Lean, poor communication and leadership, difficulty in defining waste, and the challenge of defining value from the patient's perspective (Faull and Booysen, 2007; Grove *et al.*, 2010; Naidoo, 2013). Simply identifying the challenges of Lean, however, does not necessarily translate to identifying CSFs.

In an influential study involving a systematic review of 33 articles on PubMed, Web of Science, and Business Source Premier, four different change mechanisms were identified as positive results yielded through Lean. Outlined in all 33 articles, these change mechanisms were: understanding processes; planning and organising for effectiveness and efficiency; increasing awareness and process reliability; and collaboration amongst staff to solve problems systematically (Mazzocato *et al.*, 2010).

From a seminal literature review of 177 research papers dating from 2000 to 2015 – conducted across several elements of health-care operations management, including service quality, service-operations strategy, service scheduling, service performance, and frontline employees (Jha *et al.*, 2016) – it is clear that more health-care operations-management research is required in developing and underdeveloped countries due to the unique challenges experienced in these nations in comparison with developed nations. The literature review revealed that a large proportion of empirical studies has been conducted only in developed nations (Jha *et al.*, 2016), a lack of balance that needs to be rectified.

In the reviewed literature, apart from the elaborate descriptions of the challenges and success factors for Lean implementation, mainly in non-health-care organisations, it is clear that there is a dearth of studies in the health-care sector in South Africa. None of the reviewed literature reveals any proposals or recommendations for the identification or application of CSFs for Lean in health care in South African hospitals.

Methods

The research was centred on a positivist paradigm and took the form of an observational, descriptive study with quantitative methods. The primary aim of the study was to develop a Lean Success Predictor for Rapid Initiation Tool (Lean SPRInT) for the implementation of Lean in public hospitals across KwaZulu-Natal, South Africa. Two of the study's objectives, the results of which are described in this article, were to identify the key variables for the successful initiation of Lean and then to conduct factor analysis and SEM on these variables, thus leading to the identification of CSFs for Lean initiation.

Although they remain beyond the scope and content of this article, other objectives of the study included uncovering the knowledge and experience of Lean amongst senior health-care managers in KwaZulu-Natal, South Africa, and utilising the identified CSFs to develop a Lean Success Predictor for Rapid Initiation Tool (Lean SPRInT) for the successful initiation of Lean.

From an extensive literature review, Vermaak (2008:183) established that the independent variables considered as CSFs for Lean implementation in the manufacturing sector can be classified under 8 categories: "mind-set and attitude, leadership, ordinary employees, strategic driver, basic stability, Lean promotion office, tools and techniques, and integration" (Vermaak, 2008). With permission, the researcher (and authors of this article) utilised these categories and independent variables in the data-collection tool, subjected them to Likert-scale ratings by senior health-care managers, and conducted factor analysis to identify the CSFs (dependent variables) which would be incorporated into the Lean SPRInT. This process is reflected in the conceptual framework (Figure 1).

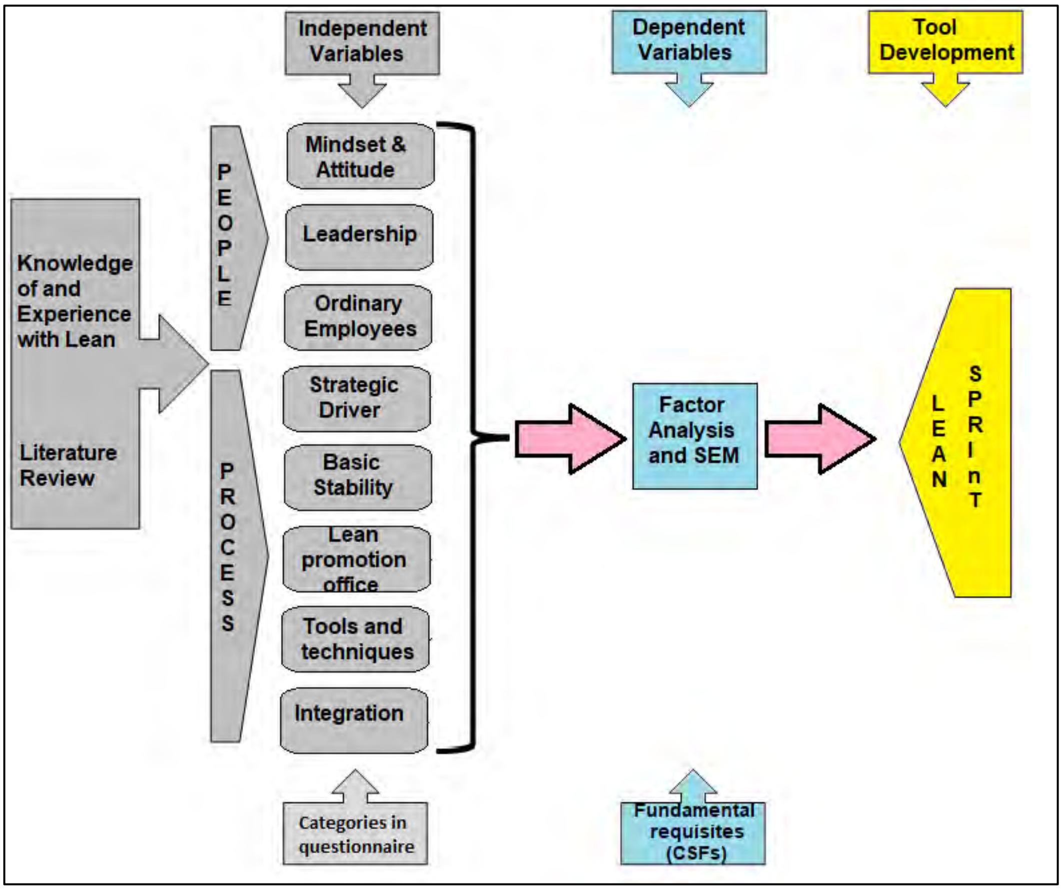

Figure 1: A conceptual framework for the current study.

Source: Author developed.

Study site, target population, and sampling

The research was conducted in public health facilities (Table 1) within the province of KwaZulu-Natal (KZN), South Africa, which is the second-most densely inhabited province of nine in the country (KZN Department of Health, 2014). KwaZulu-Natal is located in the eastern coastal region of South Africa. Its population comprised approximately 11 074 784 citizens in 2017, according to 2016 and 2017 mid-year population estimates from Stats SA (KZN Department of Health, 2018b).

Non-probability, purposive type sampling was used in order to focus the enquiry based on the particular characteristics of targeted senior managers. The target population included approximately 500 senior managers (some of them acting managers), based in 73 public hospitals in the province, consisting of the following ranks: hospital executive managers, assistant managers, operational or unit managers, and managers of clinical departments. Simple, random sampling was applied to select the participants from these categories of senior managers.

Table 1: Public health facilities in KwaZulu-Natal

Health District	**Primary Health Care (PHC) facilities**			**Hospitals (Public + State Aided)**							
	Fixed Clinics	Community Health Centers	**Total PHC Facilities**	District	Regional	Tertiary	Central	Specialised Tuberculosis	Specialised Psychiatric	Chronic/Sub-acute	**Total Hospitals**
Ugu	51	2	**53**	3	1	0	0	1	0	0	**5**
Umgungundlovu	50	3	**53**	2	1	1	0	2	3	0	**9**
Uthukela	36	1	**37**	2	1	0	0	0	0	0	**3**
Umzinyathi	53	1	**54**	4	0	0	0	0	0	0	**4**
Amajuba	25	1	**26**	1	2	0	0	0	0	0	**3**
Zululand	71	1	**72**	5	0	0	0	1+2	1	0	**9**
Umkhanyakude	57	0	**57**	5	0	0	0	0	0	0	**5**
King Cetshwayo	63	1	**64**	6	1	1	0	0	0	0	**8**
iLembe	34	2	**36**	3	1	0	0	0	0	0	**4**
Harry Gwala	39	1	**40**	4	0	0	0	1	1	0	**6**
eThekwini	119	8	**127**	3+1	6	1	1	2	1	2	**17**
TOTAL	**598**	**21**	**619**	**39**	**13**	**3**	**1**	**9**	**6**	**2**	**73**

Source: KZN Department of Health (2018b).

For exploratory factor analysis, it is proposed that a reliable sample size is one which contains *n* subjects for every test item (*p*), where *n* equals at least 5 (Costello and Osborne, 2005). Some factor analysis experts argue that the *n*:*p* ratio should be at least 3 to 6 per test item whilst others recommend a minimum of 5 per test item (Cattell, 1978; Costello and Osborne, 2005; Gorsuch, 1983). Table 2 shows that a larger proportion (a cumulative percentage of 63.2%) of studies use between 2 and 10 subjects per test item. There is no hard and fast rule to the sample size for exploratory factor analysis. In this study, there are 32 test items in the questionnaire.

Table 2: Factor analysis sample sizes in current practice

Subject to item ratio	**% of studies**	**Cumulative %**
2:1 or less	14.7%	14.7%
>2:1, ≤ 5:1	25.8%	40.5%
>5:1, ≤ 10:1	22.7%	63.2%
>10:1, ≤ 20:1	15.4%	78.6%
>20:1, ≤ 100:1	18.4%	97.0%
>100:1	3.0%	100.0%

Source: Costello and Osborne (2005).

As a result, for reliable factor analysis, a sample size of at least 192 (based on a subject: item ratio of 6:1) was required. The planned sample size of senior managers, considering a 5% margin of error and a 95% confidence interval, was 218. The response rate was 96.8% (*n*=211).

The sample size can be regarded as acceptable if the communalities are high (squared multiple correlation > 0.6) and factors relatively few in number. MacCallum *et al.* (1999) explain that, with the above conditions, the "investigator can be confident that obtained factors represent a close match to population factors even with moderate to small sample sizes" since the *n*:*p* ratio recommendations above may not be invariant across studies (MacCallum *et al.*, 1999). The communality of a variable (frequently estimated by the squared multiple correlation) can be defined as "the portion of the variance of that variable that is accounted for by the common factors" (MacCallum *et al.*, 1999).The authors further recommend *post hoc* judgement of the adequacy of the sample size used for factor analysis, by examining communalities and number of factors. Consequently, in terms of MacCallum *et al.*'s (1999) proposition, factor analysis in this study shows that communalities are high (mostly above 0.6) and factors few in number (3 factors), hence the sample of 211 is reliable (MacCallum *et al.*, 1999).

Inclusion and exclusion criteria

Any of the executive or senior managers mentioned above who declined participation in the study were excluded. All senior managers from the categories described above, based in 73 public hospitals in KZN, will be included in the sampling frame, irrespective of their duration in the post and whether or not they are acting in a vacant position.

Data collection

For the purpose of identifying key variables for the successful initiation of Lean, and then to conduct factor analysis and SEM on these variables, a self-administered, structured questionnaire with categorical and variable Likert-scale questions was used for data collection. These were distributed to 218 randomly selected senior managers across the public hospitals of KZN.

Data analysis

Statistical analyses were carried out using the SPSS® software package. Factorability of the variables was determined by measures of sampling adequacy: Kaiser-Myer-Olkin (KMO) and Bartlett's Test of Sphericity. Cronbach's alpha was used to determine the internal consistency of the test items contained in the questionnaire, looking particularly for unidimensionality (homogeneity) of items measuring latent constructs (Tavakol and Dennick, 2011). Cronbach's alpha generally >0.7 was considered acceptable (Tavakol and Dennick, 2011).

Data were reduced using exploratory factor analysis (EFA) to identify latent constructs. Confirmatory factor analysis (CFA) was used to determine the reliability and validity (both convergent and discriminant) of these factors. Structural equation modelling (SEM) fit indices were then applied to assess acceptability of the measurement model.

Results: Response rate and general characteristics of respondents

A total of 211 responses were received (96.8% response rate). Most of the respondents (43.1%) possessed more than 10 years of management experience, followed by a mediocre number (25.6%) of respondents having 5 to 10 years' management experience (Figure 2). A smaller proportion (19.0%) had had 2 to 5 years of management experience.

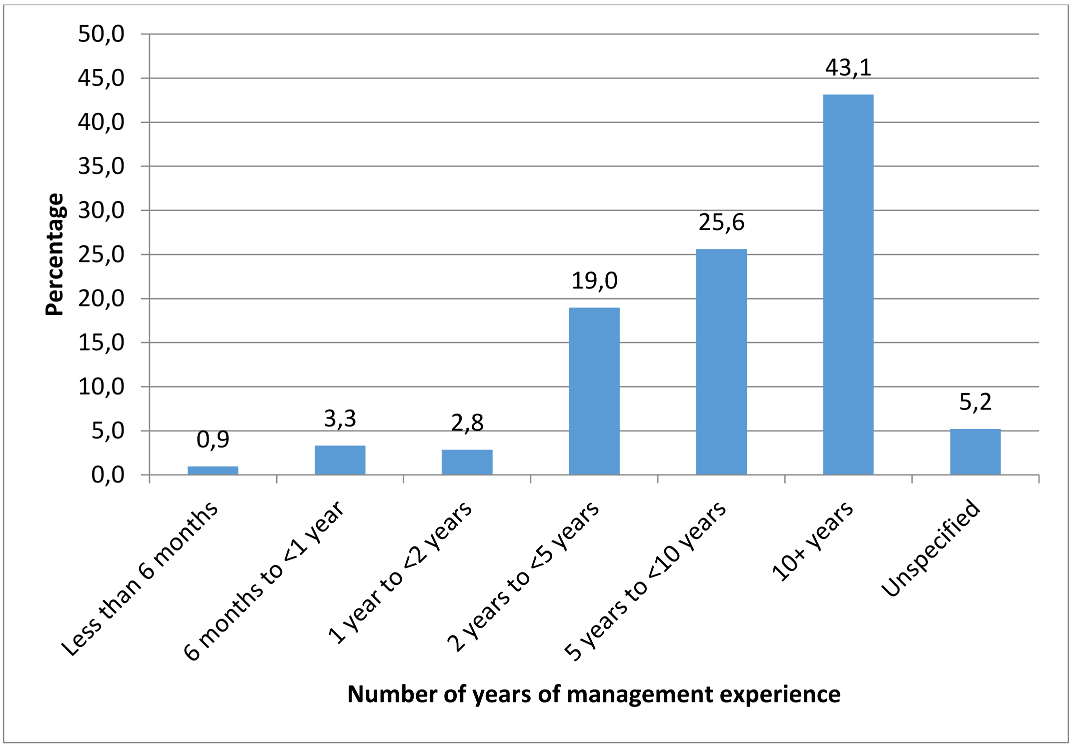

Figure 2: Respondents' management experience in years.

Exploratory Factor Analysis and Confirmatory Factor Analysis

Initial EFA produced structures that could not yield factors which showed discriminant validity. This was as a result of the very high correlations between some of the factors. Some variables were eliminated during EFA if they cross-loaded onto more than one factor, this causing discriminant validity problems. In addition, if variables loaded weakly onto a factor, they were not retained.

The CFA measurement model of the factors showing correlations is provided below, along with the tables of output for the values shown in Figure 3.

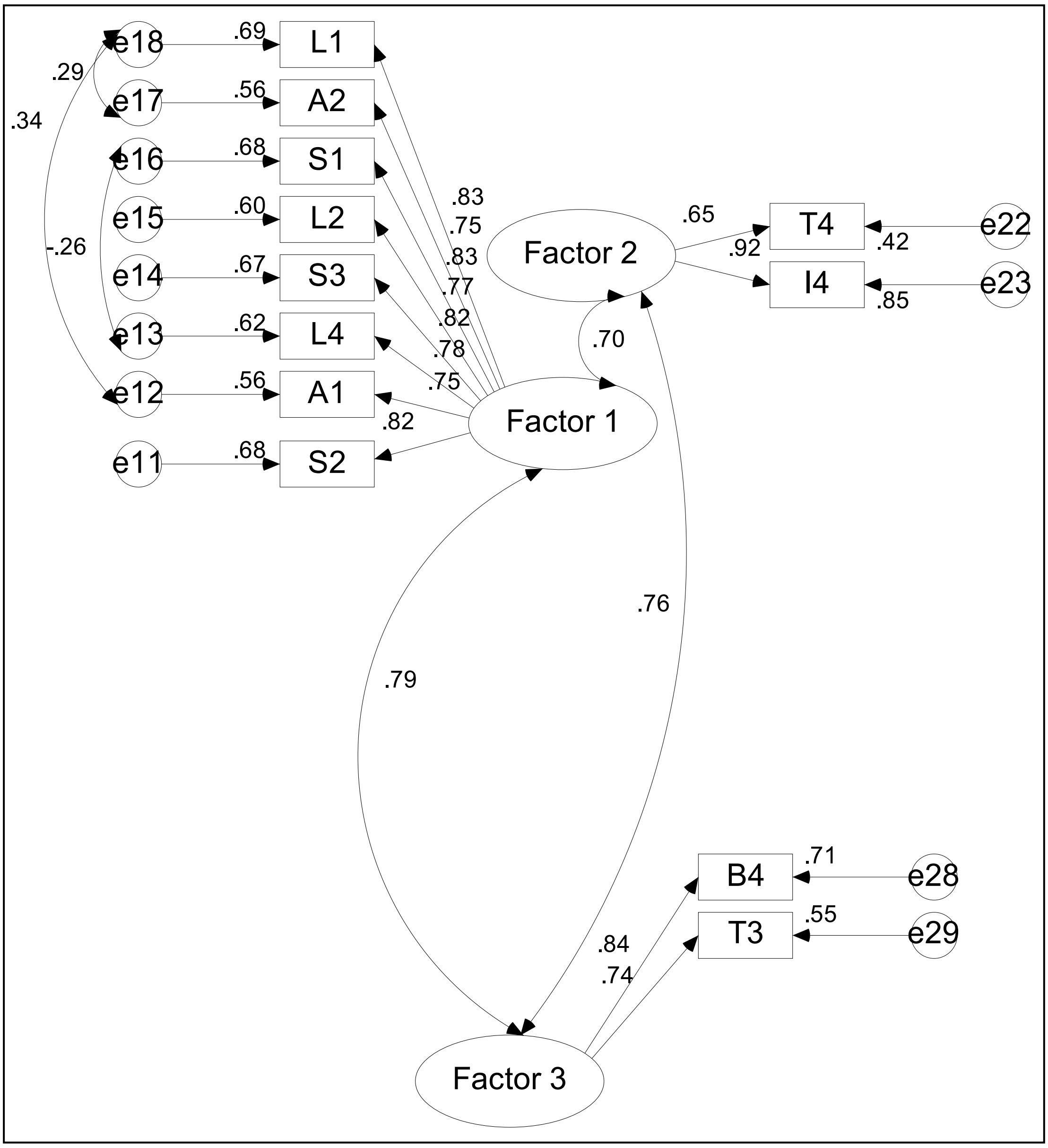

Figure 3: Depiction of confirmatory factor analysis (CFA) results.
Source: Author developed.

The standardised regression weights (SRW) or loadings of the test items or variables onto the factors are reflected in Table 3.

Table 3: Standardised Regression Weights of Test Items

Test item code		Factor label	SRW
A1	←	Factor 1	0.750
L4	←	Factor 1	0.784
S3	←	Factor 1	0.819
L2	←	Factor 1	0.774
S1	←	Factor 1	0.826
A2	←	Factor 1	0.745
L1	←	Factor 1	0.832
S2	←	Factor 1	0.824
T4	←	Factor 2	0.652
I4	←	Factor 2	0.924
B4	←	Factor 3	0.842
T3	←	Factor 3	0.743

Correlations between the factors and squared multiple correlations (communalities or the amount of variance in the observed test item or variable that the factor or construct explains) are reflected in Table 4 and Table 5, respectively.

Table 4: Correlations between Factors

Factor label		Factor label	Correlation
Factor 1	↔	Factor 2	0.696
Factor 3	↔	Factor 2	0.759
Factor 3	↔	Factor 1	0.787

Table 5: Squared Multiple Correlations of Test Items

Test item code	Squared Multiple Correlation (Communality)
S2	0.679
T3	0.551
B4	0.709
I4	0.854
T4	0.425
L1	0.693
A2	0.555
S1	0.682
L2	0.599
S3	0.671
L4	0.615
A1	0.562

Derived from EFA and CFA, three critical success factors have been identified in this study for the successful initiation of Lean in public hospitals (Table 6).

Table 6: Critical Success Factors for Lean Initiation in Hospitals

Critical Success Factors	Elements (taken from test items)
CSF 1: **Strategic leadership and organisational attitude**	L1: Leadership at all levels in the organisation must drive, live and demonstrate Lean behaviour.
	A2: An organisation implementing Lean must face and embrace the various attitudinal aspects of Lean.
	S1: Lean philosophy and principles must be reflected in the organisation's business strategy.
	L2: Lean leadership leads to Lean thinking.
	S3: Lean implementation must be driven as a high priority strategic business initiative.
	L4: The difference between Lean success and failure starts with leadership.
	A1: The mind-set and attitude or behaviour of people is fundamental to Lean success.
	S2: There must be a clear link between the organisation goals, key objectives, and Lean activities.
CSF 2: **Integration of Lean elements, tools and techniques**	I4: The organisation must use all the goals, methods, techniques, and foundation elements of Lean in combination
	T4: The application of Lean tools and techniques will ensure Lean success.
CSF 3: **Basic stability in operational processes**	T3: It is important to understand the organisation's processes and only apply the Lean tools and techniques applicable to that specific process type.
	B4: Stability in operating systems is a pre-requisite for Lean transformation.

Structural Equation Modelling Fit Indices

To assess whether this was an acceptable CFA measurement model, SEM non-centrality based fit indices were assessed (Table 7).

Table 7: Structural Equation Modelling (SEM) Non-centrality-based Fit Indices

SEM Fit Index	Recommended Cut-off Value	Value for this Model
Root mean square error of approximation (RMSEA)	<0.08 (Browne and Cudeck, 1993; Hu and Bentler, 1995) Some authors allow <0.10 for a fair/mediocre fit (MacCallum *et al.*, 1996)	0.085
Comparative fit index (CFI)	≥0.95 (Bollen, 1990; Hu and Bentler, 1999)	0.956
Relative or normed Chi square (X^2 / df)	<5 (Schumacker and Lomax, 2004b)	2.513

Reliability and validity of model

The following conditions are required for reliability and validity of the model:

- Reliability: Composite reliability (CR) > 0.7 and loadings on factors > 0.5
- Convergent validity: CR > Average variance extracted (AVE) and AVE > 0.5
- Discriminant validity: AVE > squared correlations

For this model, Table 8 shows the values of the indices used to assess for reliability and validity, based on the conditions specified above. Diagonals represent AVE, and Alpha represents Cronbach's alpha reliability measure. Off diagonals represent squared correlations (also known as shared variance).

Table 8: Squared Correlations, Composite Reliability, Average Variance Extracted, and Cronbach's Alpha for Current Model

	Squared Correlations				
Construct	**F1**	**F2**	**F3**	**CR**	**Alpha**
F1	0.632			0.932	0.934
F2	0.484	0.639		0.775	0.715
F3	0.619	0.576	.631	0.773	0.763

All reliability and validity conditions have been met, thus rendering the model reliable and valid.

Critical Success Factors identified in this study

Three CSFs have been identified in this study for the successful initiation of Lean in public hospitals: Strategic leadership and organisational attitude; Integration of Lean elements, tools and techniques; and basic stability in operational processes. Each CSF consists of elements which itemise the factor (Table 6). The elements of each factor provide a brief statement of the key requirements for health-care managers to consider prior to the initiation of Lean in public hospitals, the absence of which may impede successful Lean roll-out.

Discussion

For various manufacturing organisations, it appears that clear organisational goals, values, and vision and the communication thereof; emphasis on leadership and commitment, and resource capabilities, are acknowledged as common CSFs for Lean (Czabke *et al.*, 2008; Mefford, 2009; Pedersen and Huniche, 2011). Many studies in non-health-care industries on the CSFs for Lean implementation describe several common CSFs (Table 9). However, only one of the three identified CSFs (CSF1: Strategic leadership and organisational attitude) closely resembles some of those described in the majority of studies reviewed for non-health-care industries (Table 9).

Table 9: Corresponding Critical Success Factors for Lean Identified in Other Industries

Context and researchers	CSFs surveyed from literature (corresponding CSFs identified in current study indicated in parentheses)
CSFs relevant to measuring the degree of success of Lean implementation in Information Technology support services (Kundu & Manohar, 2012)	Management leadership (CSF1); Management support (CSF1); Top management commitment (CSF1); Organisational culture; Communication; Training and skill building; Financial Capability; Measurement framework
Implementation of Lean Manufacturing within SMEs (P. Achanga et al., 2006)	Leadership and Management (CSF1); Financial Capability; Skills and Expertise and Organisational Culture
Enablers and inhibitors	Commitment to and wish for improvement (CSF1); Clear

during the implementation of Lean in a Mexican Public service organisation (Sua´rez-Barraza & Ramis-Pujol, 2010)	resolve to improve; Focus on the simple and practical; Active leadership (CSF1); Outcome or stakeholder-oriented service; Holistic and transversal thinking; Establishing a system for measuring service process performance; Effective implementation of best Human Resource Management practices
Success factors identified during two Lean implementation projects within the same company: a global manufacturer of food processing machines and equipment (Scherrer-Rathje et al., 2009)	Management commitment to, and involvement in, the Lean effort (CSF1); Employee autonomy to make decisions regarding business process changes; Information transparency of Lean goals; Evidence of initial performance improvements and long-term sustainability of Lean efforts
A secondary review of research literature of key factors of success in the management of the Synchronized Production System (SPS) implementation process (Skrudupaite & Jucevicius, 2011)	Business plan and vision; top-management support (including funding) (CSF1); project management (including project champion and teamwork and composition); change management, organisational culture; effective communication, education and training, knowledge transfer, knowledge management (including skills and expertise); organisational structure; monitoring and evaluation of performance: performance measurements
Critical success factors within SMEs implementing lean (Kumar et al., 2009)	Management involvement and commitment (CSF1); Communication; Link quality improvement to employee; Culture change; Education and training; Link quality improvement to customer; Project selection; Link quality improvement to business; Link quality improvement to supplier; Project management skill; Organisation infrastructure; Vision and plan (CSF1); Information Technology and innovation.
Ten CSFs for software industries from a pilot study (Antony & Fergusson, 2004)	Leadership engagement and uncompromising commitment of top management (CSF1), supporting OI, cultural change, Lean training, linking Lean to business strategy, accountability, customer involvement, understanding of Lean methodology (CSF2 and CSF3), project management, project prioritization, and selection
Four essentials for successful implementation of a Lean programme (Mefford, 2009)	Belief that the new program will work; Commitment for implementing it from managers (CSF1); Involvement of the whole organisation – employees, resources; Patience and long-term view of the results

Management leadership and incorporation of Lean in the organisation as a strategic driver is paramount as a Lean CSF in research literature. The findings of this study in the KZN public hospitals corroborate this CSF as instrumental also within the health-care industry (Al-Balushi *et al.*, 2014; Andersen *et al.*, 2014; Brey, 2011; Burgess and Radnor, 2010; Emiliani and Stec, 2004). The other two CSFs (Integration of Lean elements, tools and techniques; and basic stability in operational processes) appear peculiar to several of the non-health-care industries as enablers or Lean implementation success indicators. This study, however, shows that they are nevertheless identified as critical for KZN public hospitals.

CSF 2 and CSF 3 are fundamental to the 5 Lean principles (specify value, identify the value stream, create flow, allow pull, and pursue perfection) (Womack and Jones, 1996). The application of these principles justifies these two CSFs as integral rudiments for successful Lean initiation in the health-care industry. Hospitals are rarely based on a typical assembly-line structure: they are person-orientated operations with various "patient processing" service nodes in which unique and multi-faceted events occur. This would emphasise the need for the integration of Lean elements, tools and techniques, and the requirement of basic stability in some of the value-stream processes, in order for Lean to be applied. One may ask, what is Lean without its signature elements, tools, techniques, and processes of flow in the value stream?

More importantly, each of the three CSFs cannot be viewed in isolation. All have significance in different dimensions of capability within the organisation, characteristically represented by Andersen *et al.'s* (2014) framework of Lean facilitators (Table 10).

Table 10: Andersen et al.'s Framework of Lean Facilitators Identified in Literature Reviews from 2000 to 2012

Dimensions of capability	**Domain of the intervention**			
	Context	**Content**	**Application**	**Outcomes**
	Situation and organisation	**Characteristics of the intervention**	**Local delivery process**	**Results and maintenance**
Cultural Underlying beliefs, values, norms, and behaviour	Experience	Adaptation	Teamwork	Supportive culture
	Belief	Customer focus		
Technical Training and info support systems	IT systems	Training	Administrative support	Communication
	Competence			
Strategic Strategic importance and opportunity to change	Alignment	Resources	Physicians	Holistic approach
	Vision		Management	Continuous improvement
Structural Mechanisms to facilitate learning and disseminate best practices	External support	Accurate data	Staff involvement	Measurement
				System-wide scope

Source: Andersen *et al.* (2014).

This framework suggests that the Lean CSFs and the context, content, application, and outcome of Lean should be viewed in light of the organisation's strategic, technical, structural, and cultural environment (Andersen *et al.*, 2014). Within the context (of the current situation and organisation), all three CSFs should be applied in view of the cultural, technical, strategic, and structural dimensions. The content of Lean interventions must be adapted to local conditions, with a focus on value creation for the patient, the culture of the workforce, substantial localised training on Lean tools and techniques, and accurate and robust data (Andersen *et al.*, 2014). The collaboration of multi-skilled and multidisciplinary teams in the hospital, together with administrative project management, practical support, management, and physicians' engagement at the frontline, and the empowerment of staff facilitates Lean application. Finally, a supportive environment with effective communication, feedback to employees and patients, the adoption of a holistic quality-improvement philosophy, and the establishment of a long-term continuous improvement plan in a system-wide, multifaceted approach upholds the outcomes domain of the framework (Andersen *et al.*, 2014).

The three CSFs are ultimately identified and analysed, originating from the perceptions of senior managers working in public hospitals in KZN. The statistical methods and SEM fit indices presented above provide a basis for verifying the resemblance of these identified factors to the actuality at the population level.

Conclusion

Applying EFA, CFA, and SEM, the study identified three critical success factors for the successful initiation of Lean in public hospitals in KwaZulu-Natal, South Africa. CSF 1 (Strategic leadership and organisational attitude), CSF 2 (Integration of Lean elements, tools, and techniques), and CSF 3 (Basic stability in operational processes) consist of key elements for managers to consider prior to the initiation of Lean.

Collaborative leadership and the embedding of Lean as a strategic driver is depicted in the literature as an important enabler of Lean in non-health-care industries. The study findings corroborate CSF 1 as instrumental for Lean success also within the health-care industry. The study uniquely identifies CSF 2 and CSF 3 as the other two critical success factors in KZN public hospitals, despite these being reflected in reviewed literature as having less importance in other studies. The application of the five Lean principles justifies these two CSFs as integral rudiments for successful Lean initiation in the health-care industry.

Ultimately, each of the three CSFs cannot be viewed in isolation, as they all have significance in different dimensions of capability within the organisation. The use of these CSFs and the context, content, application, and outcome of Lean should be considered in view of the organisation’s strategic, technical, structural, and cultural environment. The three identified CSFs will form the basis for the development of the Lean Success Predictor for Rapid Initiation Tool (‘Lean SPRInT’). This tool will be proposed as a Lean initiation and situational baseline assessment tool for public hospitals in KwaZulu-Natal, and also as universally applicable to South Africa.

The Lean SPRInT will be put forward as an initiation tool for managers to embark on the Lean transformation journey. Lean SPRInT uses sets of elements for the three CSFs for Lean implementation. Once rated by the user, these would yield a fuzzy-logic output of graded Lean implementation readiness levels and processes that would guide managers to initiating Lean. The calculated Lean readiness levels, ranging from 1 to 3, for each of the CSF elements allows managers to gauge the deficiencies in their institution, which once improved, would predict greater success. In addition to the Lean SPRInT, Andersen *et al.*'s (2014) framework suggests that Lean CSFs and the context, content, application, and outcome of Lean should be viewed in light of the organisation's strategic, technical, structural, and cultural environment (Andersen *et al.*, 2014).

Finally, and significantly, further research into the effectiveness of these CSFs for the introduction of Lean in South African hospitals will be beneficial to the Lean body of knowledge.

Declarations

None.

Ethics Approval and Consent to Participate

Research ethics approval (HSS/0031/016D) was obtained from the Human Social Sciences Research Ethics Committee (HSSREC) at the University of KwaZulu-Natal (UKZN). Permission was also obtained from the KZN Department of Health's Provincial Health Research and Knowledge Management unit (KZ_2016RP31_475) and Deputy Director General for Specialised Services and Clinical Support. Written informed consent was obtained from all participants. Participation was voluntary and participants could withdraw at any point. Questionnaire responses were personally collected by a research assistant via drop off points, anonymised and stored in a secure file under lock and key. No personal details of participants were obtained via the questionnaires nor published in any form.

Consent for publication

Written consent to publish results of the study was granted by the KZN Department of Health's Provincial Health Research and Knowledge Management unit. Questionnaire responses during data collection were anonymised therefore no personal or identification details of participants were collected. As a result, data acquired during the research cannot be linked to any individual participant.

Availability of data and material

Data extracted from completed questionnaires was collated onto an electronic spreadsheet. This collated data was used for statistical analysis and can be made available by the corresponding author upon request.

Competing interests

None.

Authors' contributions

Logandran Naidoo conducted the research and produced the report. Ziska Fields supervised the research.

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6.3 Conclusion

Fulfilling Objective 2 and Objective 3 of the study, this chapter and article reported on the results of factor analysis and SEM. The study identified three critical success factors for the successful initiation of Lean in public hospitals in KwaZulu-Natal, South Africa. CSF 1 (Strategic leadership and organisational attitude), CSF 2 (Integration of Lean elements, tools, and techniques), and CSF 3 (Basic stability in operational processes) are key elements for managers to consider prior to the initiation of Lean.

Collaborative leadership and the embedding of Lean as a strategic driver is depicted in the literature as an important enabler of Lean in non-health-care industries. The study findings corroborate CSF 1 as also instrumental for Lean success within the health-care industry. The study uniquely identifies CSF 2 and CSF 3 as the other two critical success factors in KZN public hospitals, despite these being reflected in reviewed literature as having less importance in other studies. The application of the five Lean principles justifies these two CSFs as integral rudiments for successful Lean initiation in the health-care industry. The three CSFs cannot be viewed in isolation, as they all have significance in various dimensions of capability within the organisation.

Leading onto Objective 4 of the study, which is to develop a Lean readiness assessment and success-prediction tool, the three identified CSFs described in this chapter form the basis for the development of the Lean SPRInT. The next chapter and its corresponding article therefore provide insight into the genesis of the Lean SPRInT based on the results described in this chapter.

7. CHAPTER SEVEN: ARTICLE 4: THE DEVELOPMENT OF THE LEAN SUCCESS PREDICTOR FOR RAPID INITIATION TOOL (LEAN SPRInT)

7.1 Introduction

This chapter and corresponding article meet the requirement of Objective 4 of the study which is to develop a Lean success predictor tool. The corresponding article is entitled "*The Lean Success Predictor for Rapid Initiation Tool (Lean SPRInT) for initiating Lean in South African public hospitals*". The results of EFA, CFA and SEM which were used to identify the CSFs, each of which consists of elements which itemise the factor, are employed in the genesis of the Lean SPRInT. This chapter explores the architecture of the Lean SPRInT in terms of the user input interface, the back-end processing of inputs, and the resultant outputs. The utility of the Lean SPRInT is described and compared with similar Lean readiness assessment tools which exist in the Lean CSF landscape.

The article has been submitted with requested amendments to the South African Business Review (SABR) in June 2019 with Reference #6410 and is currently under review (Annexure L).

7.2 Article submitted to journal

Abstract

Background

Lean implementation provides an opportunity of addressing several resource challenges in the delivery of health care. The state of readiness of health-care institutions for the initiation of Lean, and critical factors for the prediction of successful Lean implementation, are crucial information to have prior to embarking on such a venture. The Lean Success Predictor for Rapid Initiation Tool ('Lean SPRInT') is put forward as an initiation tool for managers who wish to embark on the Lean transformation journey. To ensure that deployment resources are not utilised in vain, it can be helpful having a user-friendly electronic success predicting tool as a barometer for managers to determine upfront the state of readiness of the organisation for the initiation of Lean.

Methods

The primary aim of this observational descriptive study employing quantitative methods was to develop a success predictor tool for the implementation of Lean in public hospitals across KwaZulu-Natal, South Africa. The objectives of identifying key variables, and the generation of CSFs for Lean initiation through factor analysis and structural equation modelling (SEM) led to the final objective of the research: the development of Lean SPRInT. Simple random sampling was conducted across 73 public hospitals from a target population of 500 senior managers. A planned sample size of 218 was considered appropriate for reliable exploratory factor analysis. A self-administered questionnaire was used for data collection. Factor analysis and SEM was used to identify CSFs and their elements which would be used in the development of the electronic Lean SPRInT on a Microsoft Excel® platform.

Results

A total of 211 responses were received (96.8% response rate). The results of the Likert-scale ratings were used to identify CSFs, each of which consists of elements which itemise the factor. The CSFs and their elements were incorporated into the core Lean SPRInT architecture. The Lean success predictor input screen requires the user to rate each element per its degree of existence or applicability to their organisation's current

environment in terms of Lean readiness. Squared multiple correlations are used as weights for each of the elements, which, together with the user's input ratings, generate products for each element. The Lean readiness level (1, 2 or 3) for a CSF is then provided along with commentary and recommendations which succinctly provide managers with a practical conduit for deploying resources.

Conclusions

Lean SPRInT is by no means the panacea for Lean implementation in hospitals. However, it provides a basic and user-friendly interface for data input, and yields a fuzzy-logic output of graded readiness levels and processes that guides managers to initiating Lean. To enhance the versatility of Lean SPRInT, it is advisable that a phasic approach to Lean initiation is followed. The HLA instrument is recommended as a suitable ongoing implementation assessment tool, providing control measures and corrective actions as the roll-out proceeds.

Key words: Lean thinking; Critical success factors; Lean implementation tool; Lean hospitals; Lean

Introduction

Lean thinking (or "Lean") is a management philosophy that is derived from the Toyota Production System. It utilises a systematic approach to improving organisational efficiency by eliminating waste and pursuing perfection with minimal resources (Radnor, 2011; Womack, Jones and Roos, 2007). It has been proposed that, within the current South African economic climate, amidst a myriad of health-care service-delivery challenges, efforts have to be made to achieve sustainable improvements in health with limited resources and "doing better with less" (Mayosi and Benatar, 2014; Whiteside, 2014). Thus, Lean implementation provides an opportunity of addressing several resource challenges in the delivery of health care. However, the adoption and initiation of any new management approach brings with it an array of challenges and resistance to change within organisations. The state of readiness of health-care institutions for the initiation of Lean, and critical factors for the prediction of successful Lean implementation, are crucial information to have prior to embarking on such a venture.

There is an insufficiency of research on metrics that help with Lean deployment strategies and mechanisms to initiate Lean, even though there is evidence of research on Lean transformation readiness (Ramakrishnan and Testani, 2012).

The Lean Success Predictor for Rapid Initiation Tool ('Lean SPRInT') has been developed through research on Lean's Critical Success Factors (CSFs) in the South African health sector and is put forward as an initiation tool for managers to embark on the Lean transformation journey. Lean SPRInT uses sets of elements for three CSFs for Lean implementation which, once rated by the user, would yield a fuzzy-logic output of graded readiness levels (Levels 1 to 3) and processes that guide managers to initiating Lean.

Background

Critical success factors (CSFs) can be defined as "the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organisation" (Rockart, 1979: 85). Research results show both successful and unsuccessful Lean implementation, indicating that CSFs for its initiation have to be recognised (Kundu and Manohar, 2012). However, there is scarce empirical literature to guide *how* Lean implementation is operationalised in health care (Burgess and Radnor, 2013).

Several studies reflect efforts made in identifying CSFs for Lean implementation, as well as assessing the current status of Lean implementation within organisations. However, there is limited evidence demonstrating the existence of tools for predicting at the outset the success of Lean initiation (Al-Balushi *et al.*, 2014; Doolen and Hacker, 2005; Machado Guimarães and Crespo de Carvalho, 2014; Srinivasaraghavan and Allada, 2006; Taj, 2005).

Specifically, the use of electronic tools for the initiation of Lean and predicting success is lacking. It has been argued that existing Lean assessment tools provide qualitative analysis. There is no distinct road map showing where to direct quality improvement efforts (Srinivasaraghavan and Allada, 2006). Amidst this concern, there is very limited research on metrics that aid with the deployment of Lean by determining its deployment strategy elements (Machado Guimarães and Crespo de Carvalho, 2014).

Reviewed literature (Table 1) reflects known Lean readiness and implementation assessment tools and methodology in existence, not necessarily in the health-care sector. The assessment tools and research findings described in Table 1 do not offer any success predictor instrument for Lean implementation in hospitals. The fuzzy-logic advisory system for Lean manufacturing within SMEs is possibly a tool with a purpose and output that is closest to that of Lean SPRInT. The generation of heuristic rules which would enable the "postulation of scenarios of Lean implementation" ('Do it', 'Probably do it', 'Possibly do it', and 'Do not do it') is similar to the output of Lean SPRInT, in which a fuzzy-logic output of graded readiness levels (Levels 1 to 3) guides managers to initiating Lean (Achanga, Shehab, Roy and Nelder, 2012).

To ensure deployment resources are not utilised in vain, it can be helpful to have a user-friendly success predicting tool as a barometer for health-care managers to determine upfront the state of readiness of the organisation for the initiation of Lean.

The Lean SPRInT has been developed from an intricate research process of analysing the current Lean implementation status in the South African public hospital landscape, identifying CSFs through factor analysis and structural equation modelling (SEM). Finally, CSFs and their elements, once identified, were integrated into a user-friendly electronic tool. Such a tool will capture managers' inputs, and produce readiness ratings and guidance processes for successful and rapid Lean initiation (Naidoo and Fields, 2015).

Table 1: Reviewed Literature on Existing Lean Readiness and Implementation of Assessment Tools and Methodology

Tool / methodology / Paper	Authors / developers	Description
A fuzzy-logic advisory system for Lean manufacturing within SMEs	Pius Achanga, Essam Shehab, Rajkumar Roy and Geoff Nelder.	The overall system comprises three fuzzy-logic advisory sub-systems that feed into a main system. These outputs are relative cost of Lean implementation, a company Lean readiness status and the level of value-add to be achieved (impact/benefits). The main system yielded heuristic rules that enable the postulation of scenarios of Lean implementation (Do it, Probably do it, Possibly do it and Do not do it).
A Methodology to Assess an Organization's Lean Readiness for Change	Sreekanth Ramakrishnan and Michael Testani. IBM Corporation, Human Resources, Centre for Learning and Development	Focused on developing a framework to help (1) understand an organization's readiness for a Lean transformation prior to its deployment, (2) identify areas for improvement during the Lean deployment, and (3) define balanced metrics to serve as a barometer to measure the deployment progress. The framework uses a questionnaire to gather information on Lean transformation indicators.
Applying Lean assessment tools in Chinese hi-tech industries	Shahram Taj. University of Detroit	A spreadsheet-based assessment tool is used to evaluate nine key areas of manufacturing. Participants are asked to answer questions for each area, namely inventory; team approach; processes; maintenance; layout/handling; suppliers; setups; quality; and scheduling/control. A score is given for each response in the assessment. Scores are then totaled for each of the nine areas. The results are then displayed in the score worksheet and finally a Lean profile chart is created to display the current status of the plant and the gap from their specific Lean targets
Measuring Lean readiness through the understanding of quality practices in the Turkish automotive suppliers industry (T-ASI)	Jose Arturo Garza-Reyes. The University of Derby	The paper adapts an assessment framework to conduct the evaluation of the Lean Readiness (LR) of the T-ASI. Thus, the LR assessment is based on six quality practices related to Lean, namely: processes; planning and control; human resources; top management and leadership; customer relations; and supplier relations.

Tool / methodology / Paper	Authors / developers	Description
Comprehensive Agility Measurement Tool (CAMT) (Ameya & Alok)	Ameya, S.E. and Alok, K.V. Old Dominion University, Norfolk, USA.	Measures agility on the scale of 1-5; 1 being least agile and 5 being highly agile. CAMT captures agility using 10 agility enablers and thus also points out areas lacking agility. Use of Analytic Hierarchy Process (AHP) gives flexibility to this tool and also solves the problem of changing priorities of agility enablers from enterprise to enterprise.
The Healthcare Lean Assessment (HLA) (Machado Guimarães & Crespo de Carvalho, 2014)	Machado Guimarães, C. Crespo de Carvalho, J.	A monitoring instrument for preventing returns to the comfort zone and guiding the Lean journey. The Healthcare Lean Assessment (HLA) can be used as an "as is" diagnostic tool, assessing whether each process should be improved, disrupted, or eliminated and also as an ongoing implementation assessment, providing control measures and corrective actions.
A business process change framework for examining Lean manufacturing (Motwani, 2003)	Motwani, J. Grand Valley State University, Michigan, USA	Explains the critical factors involved in the implementation of Lean utilizing a business process change framework.
Lean Construction: From Theory to Implementation (Salem, Solomon, Genaidy, & Minkarah, 2006)	Salem, O., Solomon, J., Genaidy, A. and Minkarah, I. University of Cincinnati, USA.	A "Lean assessment tool" to quantify the results of Lean implementations. The assessment tool evaluates six Lean construction elements: last planner, increased visualization, huddle meetings, first-run studies, five S's, and fail safe for quality.
A Review on Lean Manufacturing Implementation Techniques (Sundar, Balaji, & Kumar, 2014)	Sundar, R., Balaji, A.N. and Kumar, R.M.S. KLN College of Engineering, Pottapalayam, India.	A Lean route map for the organization to implement the Lean manufacturing system. Analyses of the exploratory survey results are summarized in this paper to illustrate the implementation sequence of Lean elements in volatile business environment and the finding of this review was synthesized to develop a unified theory for implementation of Lean elements.
Lean Leadership Readiness for Change: A Methodology for Lean Change Readiness and Continuous Improvement (Ramakrishnan & Testani, 2012)	Ramakrishnan, S. San José State University, USA. Testani, M.V. Binghamton University, USA	A methodology for preparing leaders to orchestrate a successful Lean Transformation, which focuses on developing transformational leadership skills across an organization's entire management team to prepare them to lead a successful Lean transformation initiative and help the organization sustain their Lean success by building a constructive and adaptive Lean Culture

Tool / methodology / Paper	Authors / developers	Description
Lean Enterprise Transformation Maturity Model: The Lean Enterprise Self-Assessment Tool (LESAT) (Nightingale & Mize, 2002)	Nightingale, D.J. and Mize, J.H. Massachusetts Institute of Technology, USA	For self-assessing the present state of "Leanness" of an enterprise and its readiness to change. It is comprised of: (1) Capability maturity model for enterprise leadership, life cycle and enabling processes, and (2) Supporting materials (Facilitator's Guide, Glossary).
Mahalanobis Taguchi Gram Schmidt System (MTGS) and the Mahalanobis distance as a Lean assessment metric (Srinivasaraghavan & Allada, 2006)	Srinivasaraghavan, J. and Allada, V. University of Missouri, USA.	Mahalanobis Taguchi Gram Schmidt System (MTGS) based methodology consists of four steps. The first three steps consist of data collection using contemporary Lean assessment tools, standardizing the data, and using the standardized data for calculating the Mahalanobis Distance (MD) by the using the MTGS method. The MTGS method provides the direction of abnormality and can be used even in cases of multi-collinear data. The fourth step helps to identify the direction of improvement for a given set of capital constraints.
Graph Theoretic Approach (GTA) for analysing the readiness of an organisation for adapting Lean thinking (Gurumurthy, Mazumdar, & Muthusubramanian, 2013)	Gurumurthy, A. Indian Institute of Management Kozhikode, India. Mazumdar, P. Process Excellence, Indus Towers Limited, India. Muthusubramanian, S. University of Calicut, India.	A Graph Theoretic Approach (GTA) has the ability to integrate and model multiple inter-related factors to comprehensively assess organizational readiness for adapting Lean thinking.

Methods

The primary aim of this observational descriptive study employing quantitative methods was to develop a Lean success predictor for rapid initiation tool (Lean SPRInT) for the implementation of Lean in public hospitals across KwaZulu-Natal (KZN), South Africa. The objectives of identifying key variables and the generation of CSFs for Lean initiation through factor analysis and structural equation modelling (SEM) led to the final objective of the research: the development of Lean SPRInT.

Study site and sampling

The research was conducted in the province of KZN, South Africa, which is the second-most populous province of the nine within the country (KZN Department of Health, 2017). KZN is located in the eastern coastal region of the country. In 2017 there were approximately 11 074 784 citizens in KZN, according to mid-year population estimates from Stats SA (KZN Department of Health, 2018a). The target population resided within the 73 public and state-aided hospitals categorised per district (Table 2). This population included approximately 500 senior managers of the following ranks (whether or not acting in the position): hospital executive managers, assistant managers, operational or unit managers and managers of clinical departments. Simple random sampling was applied to the target population to select a representative number of participants, based on the sample size calculations described below.

Table 2: Public Health Facilities in KwaZulu-Natal

Health District	**Primary Health Care (PHC) facilities**			**Hospitals (Public + State Aided)**							
	Fixed Clinics	Community Health Centers	**Total PHC Facilities**	District	Regional	Tertiary	Central	Specialised Tuberculosis	Specialised Psychiatric	Chronic/Sub-acute	**Total Hospitals**
Ugu	51	2	**53**	3	1	0	0	1	0	0	**5**
Umgungundlovu	50	3	**53**	2	1	1	0	2	3	0	**9**
Uthukela	36	1	**37**	2	1	0	0	0	0	0	**3**
Umzinyathi	53	1	**54**	4	0	0	0	0	0	0	**4**
Amajuba	25	1	**26**	1	2	0	0	0	0	0	**3**
Zululand	71	1	**72**	5	0	0	0	1+2	1	0	**9**
Umkhanyakude	57	0	**57**	5	0	0	0	0	0	0	**5**
King Cetshwayo	63	1	**64**	6	1	1	0	0	0	0	**8**
iLembe	34	2	**36**	3	1	0	0	0	0	0	**4**
Harry Gwala	39	1	**40**	4	0	0	0	1	1	0	**6**
eThekwini	119	8	**127**	3+1	6	1	1	2	1	2	**17**
TOTAL	**598**	**21**	**619**	**39**	**13**	**3**	**1**	**9**	**6**	**2**	**73**

Source: KZN Department of Health (2018b).

For exploratory factor analysis, it is argued that a reliable sample size is one which contains *n* subjects for every test item (*p*), where *n* equals at least 5 (Costello and Osborne, 2005). Some factor analysis experts argue that the *n*:*p* ratio should be at least 3 to 6 per test item (Cattell, 1978; Costello and Osborne, 2005; Gorsuch, 1983). Therefore, for reliable factor analysis, a sample size of at least 192 (based on a subject: item ratio of 6:1) was required. The planned sample size of senior managers, considering a 5% margin of error and 95% confidence interval, was 218. The response rate was 96.8% (*n*=211).

In terms of MacCallum *et al.*'s (1999) proposition that the sample size be judged acceptable if the communalities are high (squared multiple correlation > 0.6) and factors relatively few in number (3 factor in this study), the sample of 211 is reliable (MacCallum *et al.*, 1999).

Data collection

A self-administered, semi-structured questionnaire with mixed categorical, open-ended and variable 6-point Likert-scale questions was used for data collection (Ghauri and Grønhaug, 2010). Vermaak (2008:183) established that the independent variables which were identified from extensive literature review, and which were considered as critical success factors for Lean implementation in the manufacturing sector, can be classified under 8 categories: mindset and attitude, leadership, strategic driver, ordinary employees, Lean promotion office, basic stability, integration, and tools and techniques (Figure 1).

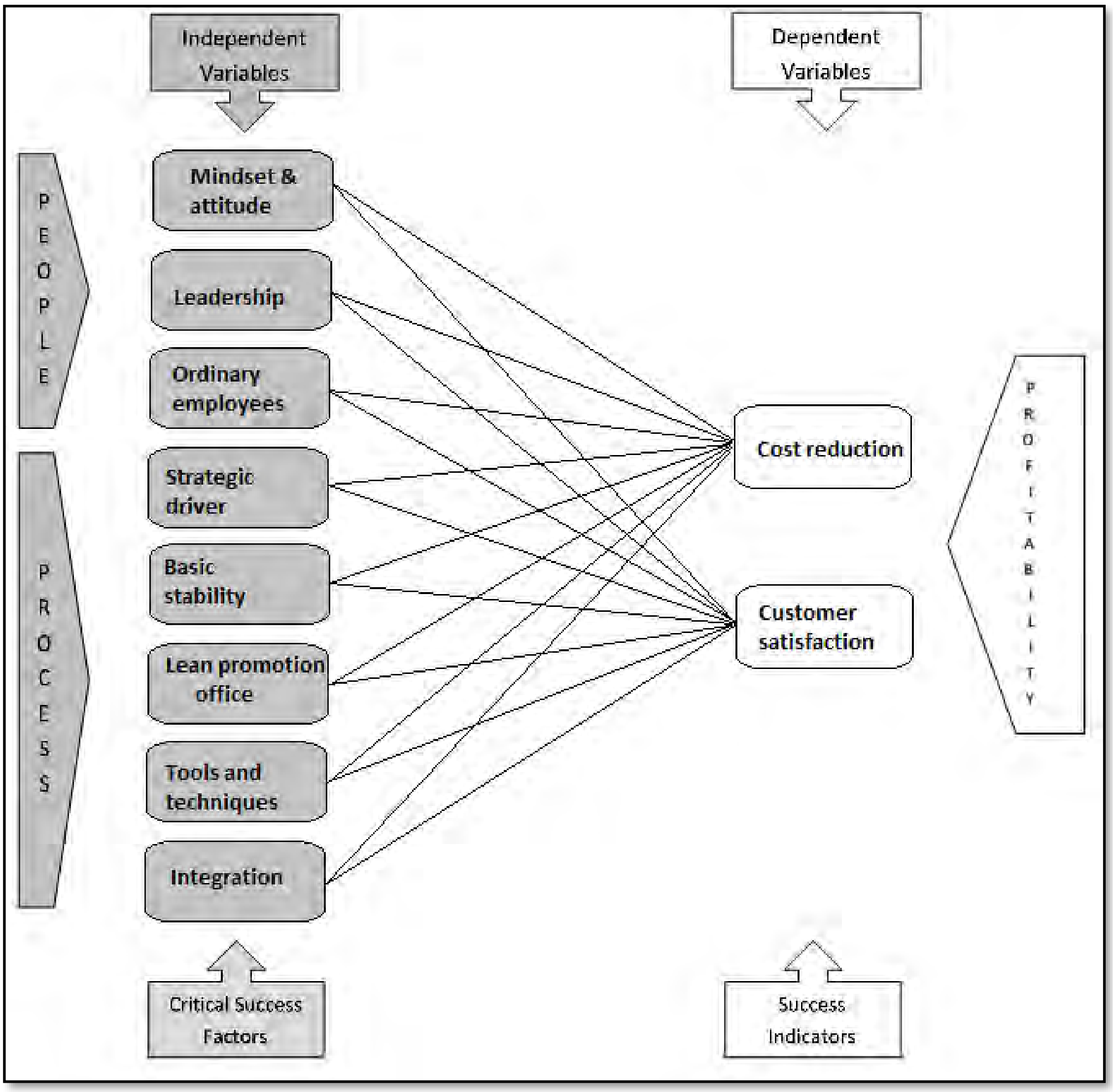

Figure 1: Model for relationship between critical success factors and success indicators of Lean in the manufacturing industry.

Source: Vermaak (2008).

The researcher utilised with permission the same categories and 32 independent variables in the research questionnaire (Table 3). The difference, however, was that these independent variables were not labelled "critical success factors" until a factor analysis and structural equation modelling was conducted based on the results of the Likert-scale ratings; with the aim of identifying CSFs that were applicable to the study setting. The independent variables for the development of the research questionnaire were adapted from Vermaak's (2008) research. Variables were randomly shuffled to avoid respondents determining any theoretical constructs or developing patterned responses to the questions.

Data analysis

Statistical analyses were carried out using the SPSS® software package. Factorability of the variables was determined by measures of sampling adequacy: Kaiser-Myer-Olkin (KMO) and Bartlett's Test of Sphericity. A KMO result of 0.8 to 1.0 would be considered acceptable (Cerny and Kaiser, 1977). Table 4 shows the adequacy of the sample for factor analysis based on a KMO of 0.884 and a statistically significant Bartlett's Test of Sphericity result. The result of Cronbach's alpha was used to determine the internal consistency of the test items contained in the questionnaire, looking particularly for unidimensionality (homogeneity) of items measuring latent constructs (Tavakol and Dennick, 2011). Cronbach's alpha generally >0.7 was considered acceptable (Tavakol and Dennick, 2011).

Table 3: Independent Variables and their Categories used in the Questionnaire

Categories	Independent Variables
Mind-set and attitude	The mind-set and attitude or behaviour of people is fundamental to Lean success.
	An organisation implementing Lean must embrace the various attitudinal aspects of Lean.
	For Lean to be successfully implemented, all levels of employees must buy into Lean.
	Employees' cognitive dimensions or perceptions of Lean are key to successful Lean implementation.
Basic stability	At the beginning of Lean transformation, the organisation needs lots of basic stability before it can proceed with the more sophisticated elements of Lean.
	General predictability and consistent availability in terms of manpower, machines, materials and methods is a pre- condition for Lean implementation.
	Work must be standardized before embarking on a Lean journey.
	Stability in operating systems is a pre-requisite for Lean transformation.
Ordinary employees	The goals of Lean can only be achieved through the efforts of its people
	Lean people make Lean organisation, and as such the people have to get Lean before the organisation can get Lean.
	The essence of Lean is people working within the Lean philosophy and principles.
	Ultimately it is the knowledge, skills, involvement and commitment of ordinary people that will make the difference to Lean success.
Lean promotion office / Lean facilitator	An organisation embarking on a Lean journey will need the support and guidance of a Lean facilitator(s) with substantial experience with Lean implementation.
	An internal Lean systems builder is needed to sustain Lean after an external expert has initiated Lean and left.
	A Lean promotion office where facilitators/ promoters of Lean can be located must be established in the organisation.
	A dedicated project leader of facilitator will have a positive impact on Lean implementation.
Integration	The organisation must integrate the soft issues of Lean (such as culture, mindset and behaviour) with the hard issues (such as tools, systems, structure and processes)
	All business systems, programmes and structures must be aligned with the Lean philosophy, principles, practices and methods.
	The effectiveness of the Lean operating system comes from the integrate nature of its practices and methods.
	The organisation must use all of the goals, methods, techniques and foundation elements of Lean in combination.
Leadership	Leadership at all levels in the organisation must drive, live and demonstrate Lean behaviour.
	Lean leadership creates/leads to Lean thinking.
	Knowledgeable and committed executive leadership is the absolute sin qua non (essential factor) for Lean success.
	The difference between Lean success and failure starts with leadership.
Strategic driver	Lean philosophy and principles must be reflected in the organization's business strategy.
	There must be a clear link between the organisation goals, key objectives and Lean activities.
	Lean implementation must be driven as a high priority strategic business initiative.
	Lean should be implemented as a business strategy and not a tactic/method.
Tools and techniques	Key to sustainable Lean performance is having the right Lean tools and techniques in place
	The selection and application of the appropriate Lean tools are critical for successful Lean implementation.
	It is important to understand the organisation's processes and only apply the Lean tools and techniques applicable to that specific process type.
	The application of Lean tools and techniques by itself will ensure Lean success.

Source: Vermaak (2008).

Table 4: Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's test of Sphericity Results

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.884
Bartlett's test of Sphericity	Approx. Chi-Square	2937.419
	df	465
	Sig.	.000

Source: Author developed.

Data was reduced using exploratory factor analysis (EFA) to identify latent constructs. Confirmatory factor analysis (CFA) was used to determine the reliability and validity (both convergent and discriminant) of these factors. Structural equation modelling (SEM) fit indices were then applied to assess acceptability of the measurement model.

Ethics

Research ethics approval (HSS/0031/016D) was obtained from the Human Social Sciences Research Ethics Committee (HSSREC) at the University of KwaZulu-Natal (UKZN). Permission was also obtained from the KZN Department of Health's Provincial Health Research and Knowledge Management unit (KZ_2016RP31_475) and Deputy Director General for Specialized Services and Clinical Support. Informed consent was obtained from all participants.

Results

A total of 211 responses were received (96.8% response rate). The results of the Likert-scale ratings were used to identify CSFs. During several iterations of exploratory factor analysis (EFA) structures, some variables were dropped along the way if variables loaded weakly onto a factor, or if they cross-loaded onto more than one factor, since this causes discriminant validity problems. The confirmatory factor analysis (CFA) measurement model of the factors showing correlations is provided in Figure 2.

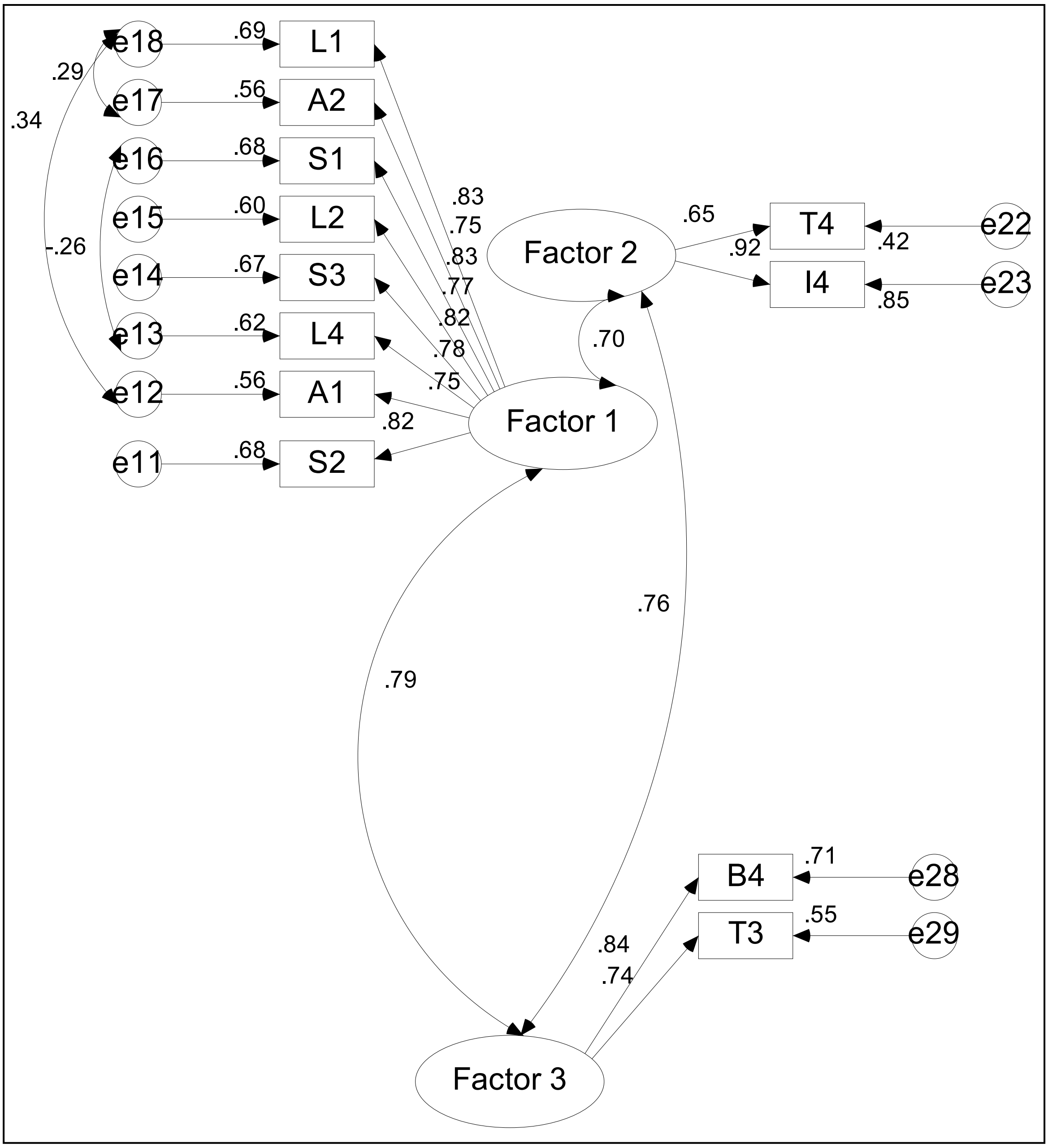

Figure 2: Depiction of confirmatory factor analysis (CFA) results.

Source: Author developed.

The Standardised Regression Weights (SRW) or loadings of the test items or variables onto the factors are reflected in Table 5.

Table 5: Standardised Regression Weights of Test Items

Test item code	Test items (CSF elements)	Factor	SRW
A1	Is the mind-set and attitude or behaviour of people in your organisation attuned to Lean success?	Factor 1	0.750
L4	Does leadership in your organisation recognise that the difference between Lean success and failure starts with leadership?	Factor 1	0.784
S3	Is Lean driven as a high priority strategic business initiative in your organisation?	Factor 1	0.819
L2	Is there a focus on Lean leadership which leads to Lean thinking in your organisation?	Factor 1	0.774
S1	Is Lean philosophy and principles reflected in your organisation's business strategy?	Factor 1	0.826
A2	Does your organisation face and embrace the various attitudinal aspects of Lean?	Factor 1	0.745
L1	Does leadership at all levels in your organisation drive, live and demonstrate Lean behaviour currently?	Factor 1	0.832
S2	Is there a clear link between your organisation goals, key objectives and Lean activities?	Factor 1	0.824
T4	Does your organisation face and embrace the various attitudinal aspects of Lean?	Factor 2	0.652
I4	Does your organisation use all of the goals, methods, techniques and foundation elements of Lean in combination?	Factor 2	0.924
B4	Does your organisation have stability in operational systems?	Factor 3	0.842
T3	Do your staff understand the organisation's processes and apply the Lean tools and techniques applicable to that specific process type?	Factor 3	0.743

Source: Author developed.

Squared multiple correlations (communalities or the amount of variance in the observed test item or variable that the factor or construct explains) are reflected in Table 6. The communality of a variable (frequently estimated by squared multiple correlation) can be defined as "the portion of the variance of that variable that is accounted for by the common factors" (MacCallum *et al.*, 1999). For example, 85.4% of the variance of the variable "use all of the goals, methods, techniques and foundation elements of Lean in combination" is accounted for by the common factor "CSF 2: Integration of Lean elements, tools and techniques".

Table 6: Squared Multiple Correlations (Communalities) of Test Items

Test item code	Test items (CSF elements)	Squared Multiple Correlation (Communality)
L1	Does leadership at all levels in your organisation drive, live and demonstrate Lean behaviour currently?	0.693
A2	Does your organisation face and embrace the various attitudinal aspects of Lean?	0.555
S1	Is Lean philosophy and principles reflected in your organisation's business strategy?	0.682
L2	Is there a focus on Lean leadership which leads to Lean thinking in your organisation?	0.599
S3	Is Lean driven as a high priority strategic business initiative in your organisation?	0.671
L4	Does leadership in your organisation recognise that the difference between Lean success and failure starts with leadership?	0.615
A1	Is the mind-set and attitude or behaviour of people in your organisation attuned to Lean success?	0.562
S2	Is there a clear link between your organisation goals, key objectives and Lean activities?	0.679
I4	Does your organisation use all of the goals, methods, techniques and foundation elements of Lean in combination?	0.854
T4	Does your organisation face and embrace the various attitudinal aspects of Lean?	0.425
T3	Do your staff understand the organisation's processes and apply the Lean tools and techniques applicable to that specific process type?	0.551
B4	Does your organisation have stability in operational systems?	0.709

Source: Author developed.

Validity and reliability of model

The following conditions are required for reliability and validity of the model:

- Reliability: Composite Reliability (CR) > 0.7 and loadings on factors > 0.5
- Convergent validity: CR > Average Variance Extracted (AVE) and AVE > 0.5
- Discriminant validity: AVE > squared correlations

For this model, Table 7 shows the values of the indices used to assess for reliability and validity, based on the conditions specified above. Diagonals represent AVE and Alpha represents Cronbach's alpha reliability measure. Off diagonals represent squared correlations (also known as shared variance).

Table 7: Squared correlations, composite reliability, average variance extracted and Cronbach's alpha for current model

	Squared correlations				
Construct	**Factor 1**	**Factor 2**	**Factor 3**	**CR**	**Alpha**
Factor 1	0.632			0.932	0.934
Factor 2	0.484	0.639		0.775	0.715
Factor 3	0.619	0.576	.631	0.773	0.763

Source: Author developed.

All reliability and validity conditions have been met, thus rendering the model reliable and valid.

Critical Success Factors identified in this study

Three CSFs for the successful initiation of Lean in public hospitals have been identified in this study. Each CSF consists of the same corresponding elements which itemise the factor and is based on the CFA and SEM results which were shown above to be valid and reliable (Table 8). The elements of each factor provide a brief statement of the key requirements for health-care managers to consider prior to the initiation of Lean in public hospitals, the absence of which may impede successful Lean roll-out.

Table 8: Critical Success Factors (and respective Cronbach's Alpha) for Lean Initiation in Hospitals

Critical Success Factors and respective Cronbach's Alpha	Elements (taken from test items)
CSF 1: **Strategic Leadership and Organisational Attitude** **(Cronbach's Alpha: 0.934)**	L1: Leadership at all levels in the organisation must drive, live and demonstrate Lean behaviour. A2: An organisation implementing Lean must face and embrace the various attitudinal aspects of Lean.
	S1: Lean philosophy and principles must be reflected in the organisation's business strategy.
	L2: Lean leadership leads to Lean thinking. S3: Lean implementation must be driven as a high priority strategic business initiative.
	L4: The difference between Lean success and failure starts with leadership.
	A1: The mind-set and attitude or behaviour of people is fundamental to Lean success. S2: There must be a clear link between the organisation goals, key objectives and Lean activities.
CSF 2: **Integration of Lean elements, tools and techniques** **(Cronbach's Alpha: 0.715)**	I4: The organisation must use all of the goals, methods, techniques and foundation elements of Lean in combination T4: The application of Lean tools and techniques will ensure Lean success.
CSF 3: **Basic stability in operational processes** **(Cronbach's Alpha: 0.763)**	T3: It is important to understand the organisation's processes and only apply the Lean tools and techniques applicable to that specific process type.
	B4: Stability in operating systems is a pre-requisite for Lean transformation.

Source: Author developed.

Development and depiction of the Lean SPRInT

Lean SPRInT version 1.0 currently uses a Microsoft® Excel platform and user interface. Demographics and user details are captured on the landing screen (Figure 3). For public hospitals in KZN, there is a drop-down menu from which to select a hospital name. The hospital classification and its number of beds is displayed automatically from a back-end database.

Thereafter, the user switches over to the Lean success predictor input screen (Figure 4). Each CSF element forms the backbone of the Lean SPRInT success predictor input interface. The Lean success predictor input screen requires the user to select ratings from a drop-down menu, based on a Likert scale (“strongly agree”=4, “agree”=3, “disagree”=2 and “strongly disagree”=1), for each element, as an indication of their degree of existence or applicability to their organisation’s current environment in terms of Lean readiness.

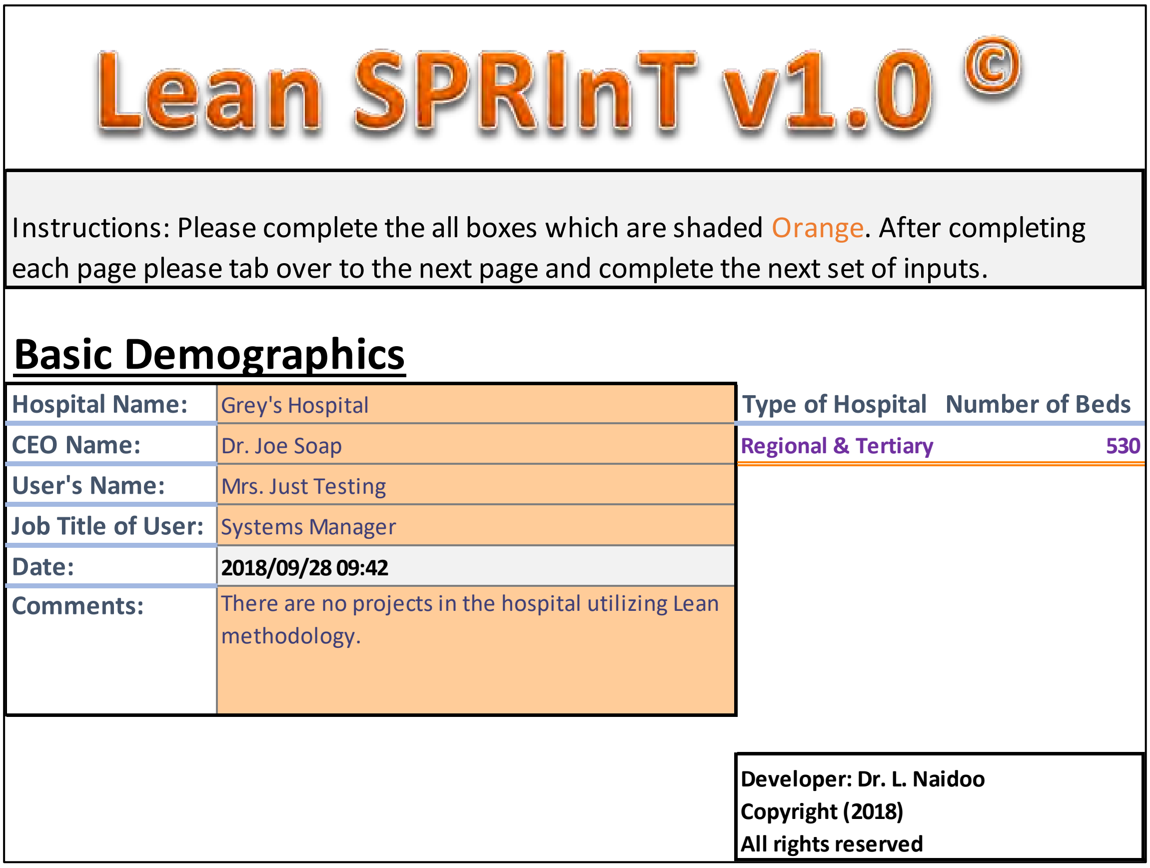

Figure 3: Lean SPRInT landing screen for input of demographic and user details.

Source: Author developed.

Lean SPRInT v1.0©

Success Predictor Input

	Strategic leadership and organisational attitude	User's Rating	SRW^2	Calculated Score
L1	Does leadership at all levels in your organisation drive, live and demonstrate Lean behavior currently?		0.693	#N/A
A2	Does your organisation face and embrace the various attitudinal aspects of Lean?		0.555	#N/A
S1	Is Lean philosophy and principles reflected in your organisation's business strategy?		0.682	#N/A
L2	Is there a focus on Lean leadership which leads to Lean thinking in your organisation?		0.599	#N/A
S3	Is Lean driven as a high priority strategic business initiative in your organisation?		0.671	#N/A
L4	Does leadership in your organisation recognise that the difference between Lean success and failure starts with leadership?		0.615	#N/A
A1	Is the mindset and attitude or behavior of people in your organisation attuned to Lean success?		0.562	#N/A
S2	Is there a clear link between your organisation goals, key objectives and Lean activities?		0.679	#N/A
	Assessment of CSF 1	Please complete rating table		
	Readiness of your hospital with regard to Strategic Leadership and Organisational Attitude	Available when rating done		

	Integration of Lean elements, tools and techniques	User's Rating	SRW^2	Calculated Score
I4	Does your organisation use all of the goals, methods, techniques and foundation elements of Lean in combination?		0.854	#N/A
T4	Does your organisation face and embrace the various attitudinal aspects of Lean?		0.425	#N/A
	Assessment of CSF 2	Please complete rating table		
	Readiness of your hospital with regard to Integration of Lean elements, tools and techniques	Available when rating done		

	Basic stability in operational processes	User's Rating	SRW^2	Calculated Score
T3	Do your staff understand the organisation's processes and apply the Lean tools and techniques applicable to that specific process type?		0.551	#N/A
B4	Does your organisation have stability in operational systems?		0.709	#N/A
	Assessment of CSF 3	Please complete rating table		
	Readiness of your hospital with regard to Strategic Leadership and Organisational Attitude	Available when rating done		

Global Assessment

Available after all above assessments done

Figure 4: Lean SPRInT success predictor input screen.

Source: Author developed.

At the back end of Lean SPRInT, the squared multiple correlations (communalities) or squares of the standardised regression weights (SRW^2) are used as weights for each of the elements in the input interface. These weights, together with the user's input ratings (1 to 4), generate products (calculated scores) for each element, i.e., user rating x SRW^2. Figure 5, Figure 6, and Figure 7 show examples of simulated user inputs, SRW^2 (weights) and calculated scores for CSF 1, CSF 2 and CSF 3 elements, respectively.

The maximum calculated score for each element is the product of 4 (maximum possible user rating) and the SRW^2 for that element, whereas the minimum calculated score is the product of 1 (minimum possible user rating) and the SRW^2 for that element. The sum of the maximum calculated scores for the elements of a particular CSF provides the maximum calculated score for that CSF. Likewise, the sum of the minimum calculated scores for the elements of a particular CSF provides the minimum calculated score for that CSF.

The overall range of scores for a CSF is divided equally into three subcategories or tripartite ranges which correlate with a particular Lean readiness level (1, 2 or 3) for that CSF. The Lean readiness level for a CSF is then determined by placing the total calculated score for a particular CSF within one of the tripartite ranges for that CSF (Table 9). The overall range of scores for the final prediction of Lean readiness for the organisation is also divided equally into three subcategories (Table 9) which correlate with an organisational Lean readiness level (1, 2 or 3).

Table 9: Minimum and Maximum Scores for the Various Lean Readiness Levels in Terms of the three CSFs and the Overall Total Score

	Category	Minimum score (1x SRW ^{2})	Maximum score (4x SRW ^{2})	Readiness levels
Scores for Total	Total	7,595	15,19	Readiness level 1
	Total	15,2	22,785	Readiness level 2
	Total	22,786	30,38	Readiness level 3
Scores for CSF1	CSF1	5,056	10,112	Readiness level 1
	CSF1	10,113	15,168	Readiness level 2
	CSF1	15,169	20,224	Readiness level 3
Scores for CSF2	CSF2	1,279	2,558	Readiness level 1
	CSF2	2,559	3,837	Readiness level 2
	CSF2	3,838	5,116	Readiness level 3
Scores for CSF3	CSF3	1,26	2,52	Readiness level 1
	CSF3	2,53	3,78	Readiness level 2
	CSF3	3,79	5,04	Readiness level 3

Source: Author developed.

Lean SPRInT's output screen (Figure 8) with calculated Lean readiness levels, ranging from 1 to 3 (most favourable to most unfavourable prediction of readiness, respectively), is supplemented by commentary and recommendations to the user. These recommendations succinctly provide managers with a practical conduit for deploying resources without having to embark on the Lean journey blindly. This ensures that the ultimate aim of Lean SPRInT is met successfully in determining upfront the state of Lean readiness by capturing managers' inputs and producing readiness ratings and recommendations for successful Lean initiation.

The culmination of the research in a tool that is both user-friendly and simple to use by health-care managers wanting to roll out Lean in their institutions augurs well for the Lean body of knowledge.

	Strategic leadership and organisational attitude	User's Rating	SRW^2	Calculated Score
L1	Does leadership at all levels in your organisation drive, live and demonstrate Lean behavior currently?	Agree	0.693	**2.079**
A2	Does your organisation face and embrace the various attitudinal aspects of Lean?	Agree	0.555	**1.665**
S1	Is Lean philosophy and principles reflected in your organisation's business strategy?	Strongly Agree	0.682	**2.728**
L2	Is there a focus on Lean leadership which leads to Lean thinking in your organisation?	Strongly Disagree	0.599	**0.599**
S3	Is Lean driven as a high priority strategic business initiative in your organisation?	Strongly Agree	0.671	**2.684**
L4	Does leadership in your organisation recognise that the difference between Lean success and failure starts with leadership?	Strongly Agree	0.615	**2.46**
A1	Is the mindset and attitude or behavior of people in your organisation attuned to Lean success?	Strongly Agree	0.562	**2.248**
S2	Is there a clear link between your organisation goals, key objectives and Lean activities?	Disagree	0.679	**1.358**

Figure 5: Simulated user inputs, SRW^2 (weights) and calculated scores for CSF 1 elements

Source: Author developed.

Integration of Lean elements, tools and techniques	User's Rating	SRW^2	Calculated Score
Does your organisation use all of the goals, methods, techniques and foundation elements of Lean in combination?	Strongly Agree	0.854	**3.416**
Does your organisation face and embrace the various attitudinal aspects of Lean?	Strongly Disagree	0.425	**0.425**

Figure 6: Simulated user inputs, SRW^2 (weights) and calculated scores for CSF 2 elements

Source: Author developed

Basic stability in operational processes	User's Rating	SRW^2	Calculated Score
Do your staff understand the organisation's processes and apply the Lean tools and techniques applicable to that specific proc	Strongly Agree	0.551	**2.204**
Does your organisation have stability in operational systems?	Agree	0.709	**2.127**

Figure 7: Simulated user inputs, SRW^2 (weights) and calculated scores for CSF 3 elements

Source: Author developed.

Lean SPRInT v1.0© Success Predictor Input

	Strategic leadership and organisational attitude	User's Rating	SRW^2	Calculated Score
L1	Does leadership at all levels in your organisation drive, live and demonstrate Lean behavior currently?	Agree	0.693	2.079
A2	Does your organisation face and embrace the various attitudinal aspects of Lean?	Disagree	0.555	1.11
S1	Is Lean philosophy and principles reflected in your organisation's business strategy?	Strongly Agree	0.682	2.728
L2	Is there a focus on Lean leadership which leads to Lean thinking in your organisation?	Strongly Agree	0.599	2.396
S3	Is Lean driven as a high priority strategic business initiative in your organisation?	Agree	0.671	2.013
L4	Does leadership in your organisation recognise that the difference between Lean success and failure starts with leadersh	Agree	0.615	1.845
A1	Is the mindset and attitude or behavior of people in your organisation attuned to Lean success?	Strongly Disagre	0.562	0.562
S2	Is there a clear link between your organisation goals, key objectives and Lean activities?	Strongly Agree	0.679	2.716
	Assessment of CSF 1	**15.449**		
	Readiness of your hospital with regard to Strategic Leadership and Organisational Attitude	**Readiness level 3**		

	Integration of Lean elements, tools and techniques	User's Rating	SRW^2	Calculated Score
I4	Does your organisation use all of the goals, methods, techniques and foundation elements of Lean in combination?	Disagree	0.854	1.708
T4	Does your organisation face and embrace the various attitudinal aspects of Lean?	Agree	0.425	1.275
	Assessment of CSF 2	**2.983**		
	Readiness of your hospital with regard to Integration of Lean elements, tools and techniques	**Readiness level 2**		

	Basic stability in operational processes	User's Rating	SRW^2	Calculated Score
T3	Do your staff understand the organisation's processes and apply the Lean tools and techniques applicable to that specifi	Strongly Agree	0.551	2.204
B4	Does your organisation have stability in operational systems?	Strongly Agree	0.709	2.836
	Assessment of CSF 3	**5.04**		
	Readiness of your hospital with regard to Strategic Leadership and Organisational Attitude	**Readiness level 3**		

Global Assessment	23.472
Grey's Hospital: Readiness level 3	

Figure 8: Lean SPRInT simulated outputs.

Source: Author developed.

Discussion

The three CSFs identified through factor analysis and SEM are considered robust predictors of indicating success of Lean initiation in hospitals, all reliability and validity conditions having been met. For managers of hospitals seeking to prognosticate the successful realization of Lean initiation in their institutions, the utility of the CSFs and their elements is demonstrated by the outputs of the Lean SPRInT with a fair degree of accuracy.

Five categories of Lean implementation initiatives proposed in previous research studies are described: conceptual frameworks, implementation frameworks, road maps, descriptive and assessment checklist (Mostafa *et al.*, 2013). In the context of this study, it is important to elaborate on the category of the Lean implementation initiative which the Lean SPRInT assesses. Although the tool resembles an assessment checklist, a conceptual framework was used to identify the CSFs and to develop the Lean SPRInT. It is posited that implementation frameworks have highest success rates for Lean initiation (Mostafa *et al.*, 2013). However, the failures in Lean initiation processes are often ascribed to "poor mind-set and inadequate understanding of the Lean concept itself" rather than the quality of the initiation tools (Mostafa *et al.*, 2013).

Lean SPRInT provides outputs similar to the fuzzy-logic advisory system for Lean manufacturing within SMEs in terms of the generation of heuristic rules which would enable the postulation of scenarios of Lean implementation (Achanga *et al.*, 2012). The calculated Lean readiness levels, ranging from 1 to 3, for each of the CSF elements allows managers to gauge the deficiencies in their institution, which, once improved, would portend a more favourable success.

Although the output of Lean SPRInT does not consider sequenced implementation, it is advisable that a phasic approach to Lean initiation is followed (Mostafa *et al.*, 2013). A useful model is depicted in Figure 9. One benefit of using a sequenced approach is the integration of the monitoring and evaluation process to ensure that results within each phase of implementation are delivered according to the organisational expectations (Mostafa *et al.*, 2013). Milestones would mark the end of each phase of the rollout, such that a go or no-go decision can be made before entering the next phase.

Lean SPRInT can thus be applied in each implementation phase as a fuzzy-logic gate for deciding on whether to proceed to the next phase. For example, a low readiness level 3 rating would imply a no-go decision and necessitate the elements within the phase to be repeated until they meet organisational expectations for Lean implementation (Mostafa *et al.*, 2013).

The success of Lean implementation is also determined by its monitoring and controls to prevent slippage. Lean SPRInT is not a monitoring tool, as it does not assess the degree of improvements made nor the pitfalls during Lean implementation. The health-care lean assessment tool (HLA) has been proposed as a useful monitoring instrument for providing a current-state diagnosis of the implementation process, thus guiding the Lean journey (Machado Guimarães and Crespo de Carvalho, 2014). The HLA tool assesses whether each process should be improved, disrupted, or eliminated. The HLA tool can therefore be used as an instrument for ongoing assessment of implementation, providing control measures and corrective actions (Machado Guimarães and Crespo de Carvalho, 2014).

Lean SPRInT, as a success predictor instrument, is by no means the panacea for Lean implementation in hospitals. However, the tool prepares managers embarking on a Lean journey by providing them with a current-state assessment of their organisation in terms of the elements of the 3 CSFs. The use of Lean SPRInT should be integrated in a phasic Lean implementation framework such that the assessment outputs will facilitate appropriate resource deployment as the Lean journey progresses from one phase to the next.

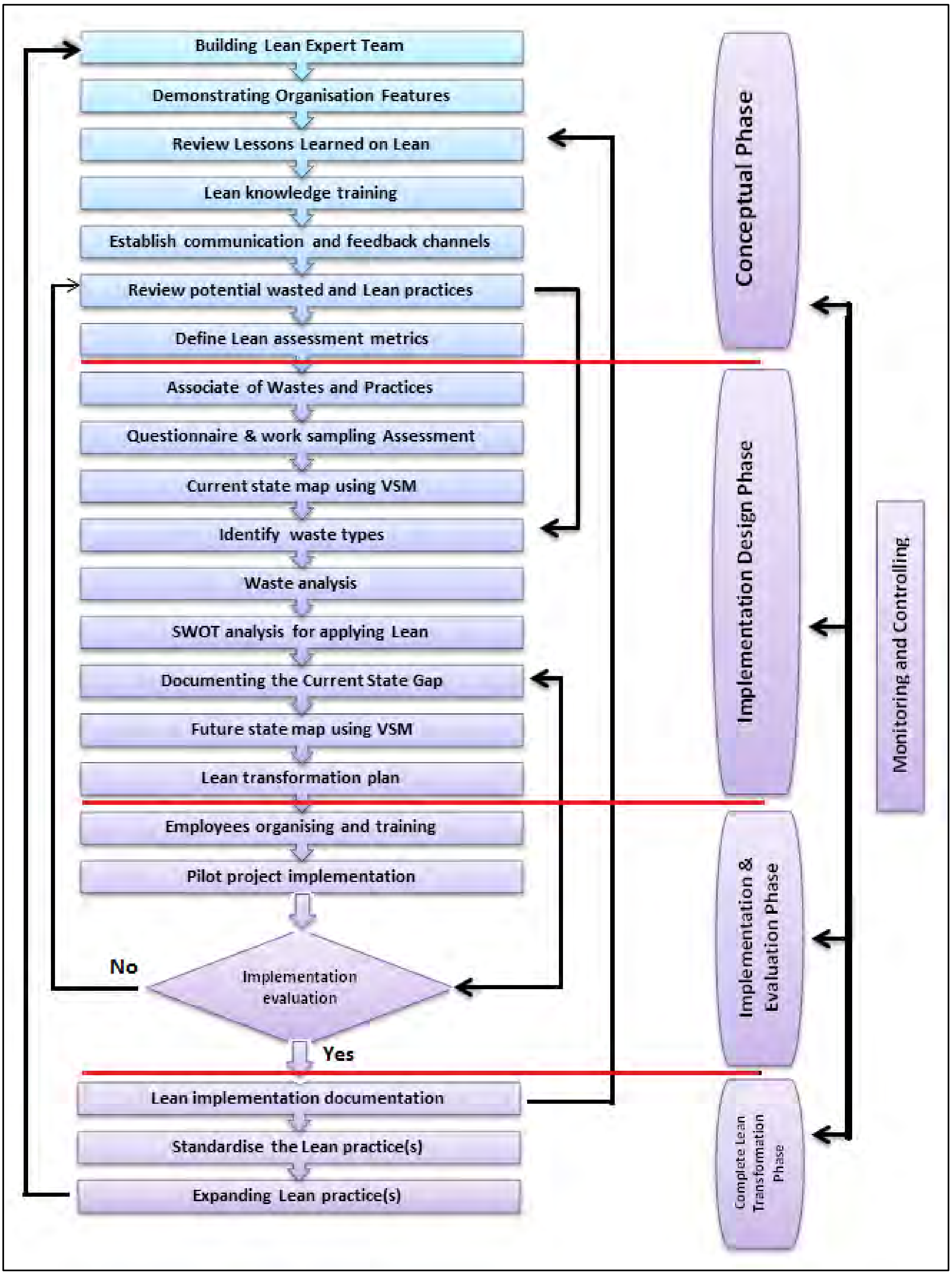

Figure 9: A proposed framework for phasic Lean implementation.

Source: Mostafa *et al.* (2013).

Conclusions

Lean SPRInT uses sets of elements of three CSFs for Lean implementation which have been identified through an intricate research process involving factor analysis and SEM. The Lean SPRInT provides a very basic and user-friendly interface for data input and yields a fuzzy-logic output of graded readiness levels and processes that guide managers to initiating Lean.

It is important to note that, although the level of success prediction is fairly accurate from a theoretical perspective, several factors play a role in the deployment of Lean (Mostafa *et al.*, 2013). The possible failures in Lean initiation processes are often associated with poor mindset and inadequate understanding of the Lean concept itself, rather than the quality of the initiation tools (Mostafa *et al.*, 2013).

To enhance the versatility of Lean SPRInT, it is advisable that a phasic approach to Lean initiation be followed. The tool could be integrated in a sequential Lean implementation framework to facilitate appropriate resource deployment as the Lean journey progresses. The HLA instrument is recommended as a suitable ongoing implementation assessment tool, providing control measures and corrective actions as the roll-out proceeds (Machado Guimarães and Crespo de Carvalho, 2014). The researcher and developer of Lean SPRInT endeavours to further enhance and evaluate the functionality and application of the tool as funding becomes available.

Competing interests

None.

Authors' contributions

Logandran Naidoo conducted the research and produced the report. Ziska Fields supervised the research.

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7.3 Conclusion

This chapter and corresponding article recapitulated the literature on Lean readiness assessment tools and detailed the development and architecture of the Lean SPRInT. The tool uses sets of elements of three CSFs for Lean implementation which have been identified through an intricate research process involving factor analysis and SEM. The Lean SPRInT provides a very basic and user-friendly interface for data input, and yields a fuzzy-logic output of graded readiness levels and processes that guides managers to initiating Lean.

It is important to note that, although the level of success prediction is fairly accurate from a theoretical perspective, several factors play a role in the deployment of Lean (Mostafa *et al.*, 2013). The possible failures in Lean initiation processes are often associated with poor mindset and inadequate understanding of the Lean concept itself, rather than with the quality of the initiation tools (Mostafa *et al.*, 2013).

To enhance the versatility of Lean SPRInT, it is advisable that a phasic approach to Lean initiation be followed. The article described how the tool could be integrated into a sequential Lean implementation framework to facilitate appropriate resource deployment as the Lean journey progresses. The researcher and developer of Lean SPRInT endeavours to further enhance and evaluate the functionality and application of the tool as funding becomes available.

With the development of the Lean SPRInT having been described, its deployment on a large scale in public hospitals becomes necessary to fully capitalise on its purpose. The next chapter and corresponding article are related to the Conclusion and Recommendations chapter of this thesis, and provide details of a proposal for Lean SPRInT deployment.

8. CHAPTER EIGHT: ARTICLE 5: THE DEPLOYMENT OF LEAN SPRInT: A MANAGEMENT TOOL FOR INITIATING LEAN IN PUBLIC HOSPITALS IN KWAZULU-NATAL

8.1 Introduction

This chapter represents the article entitled "*Lean SPRInT: A management tool for initiating Lean in public hospitals in KwaZulu-Natal*". The purpose of this article corresponds to the conclusion and recommendations derived from the study. It proposes a trajectory for the large-scale deployment of the Lean SPRInT in the KwaZulu-Natal Department of Health with the aim of implementing Lean in health facilities. A 6-step Lean roadmap, incorporating the Lean SPRInT is described, along with a framework for phasic Lean implementation and the Shingo transformation model for sustainability.

The article has been submitted to and published in Volume 16 (Issue 2) of the Journal of Contemporary Management in July 2019 with Reference JCM 19-030 (Annexure M).

8.2 Article published in Journal of Contemporary Management

ABSTRACT

South African public hospitals are beset with barriers to the realization of strategic health outcomes owing to operational inefficiency. The Lean SPRInT aids managers with Lean implementation by assessing their hospitals' readiness status for Lean to improve operational efficiency.

An observational descriptive study employing quantitative methods was conducted across 73 public hospitals in KwaZulu-Natal (KZN). Simple random sampling was used to attain a minimum sample size of 218 senior managers who completed semi-structured questionnaires. Exploratory factor analysis (EFA) was used to identify latent constructs. Confirmatory factor analysis (CFA) was used to determine the reliability and validity of factors. Structural equation modelling (SEM) assessed the acceptability of the model.

The participant response rate was 96.8% (n=211). Three critical success factors (CSFs) (strategic leadership and organisational attitude; integration of Lean elements, tools and techniques; and basic stability in operational processes), from which the electronic Lean SPRInT was developed, were derived after several iterations of exploratory factor analysis (EFA). All reliability and validity conditions have been met, thus rendering the model reliable and valid.

Lean SPRInT is a management tool for assessing hospitals' readiness status for Lean. A six-step process for the deployment of Lean SPRInT is proposed. A phasic approach for Lean implementation, together with close monitoring using the HLA tool is recommended. Unified efforts and decentralised decision-making are more likely to lead to effective implementation.

Key phrases

Contemporary management tool; health-care management; health-care system; lean management and operational efficiency

1. INTRODUCTION

The ultimate goal of a health-care system is to provide quality and affordable health care to society. A healthier nation would enjoy the benefit of financial risk protection and a satisfied population (Yip and Hafez, 2015:5-6). Several resources inputs are impelled by policy instruments and form the recipe for quality of and access to health care, which ultimately leads to the desired health benefit to society (Figure 1). Both health-care quality and benefits are important outcomes of efficiency in the health-care system that may lead to the achievement of improved access and quality with the least amount of resource inputs.

Lean thinking (or "Lean") is recognised as a systematic approach to improve efficiency by eliminating waste and pursuing perfection with minimal resources (Omogbai and Salonitis, 2016:106; Røvik and Andersen, 2015:1; Womack, Jones and Roos, 2007:1). The primary focus of Lean is on reducing waste, synchronising flows and managing variability in (process) flows. A critical aspect of Lean is the empowerment of employees to make changes to their work, thereby improving processes from the floor upwards. On an organisational level, mapping the entire process allows management to augment process steps that are value-adding and relevant to the final product or service for the customer, while systematically eradicating those that fail to add value (Dickson, Singh, Cheung, Wyatt and Nugent, 2009). Lean methodology is pinned on five tenets (Zidel, 2006):

- **Specify value** by asking oneself what is valuable to the end-user (the patient);
- **Identify the value stream** using a Value Stream Map (VSM);
- **Make the value stream flow** by restructuring process steps and eliminating, non-value-adding steps (eliminating bottlenecks);
- **Pull**: The forerunning process down the value-stream signals when upstream activities can begin in order to stabilise demand on the system; and
- **Pursue perfection** through continuous improvement.

Wide-scale adoption of such a management approach in health-care facilities would contribute to the attainment of the aforementioned goal. See Figure 1 for a systems framework for operational efficiency in a health-care system.

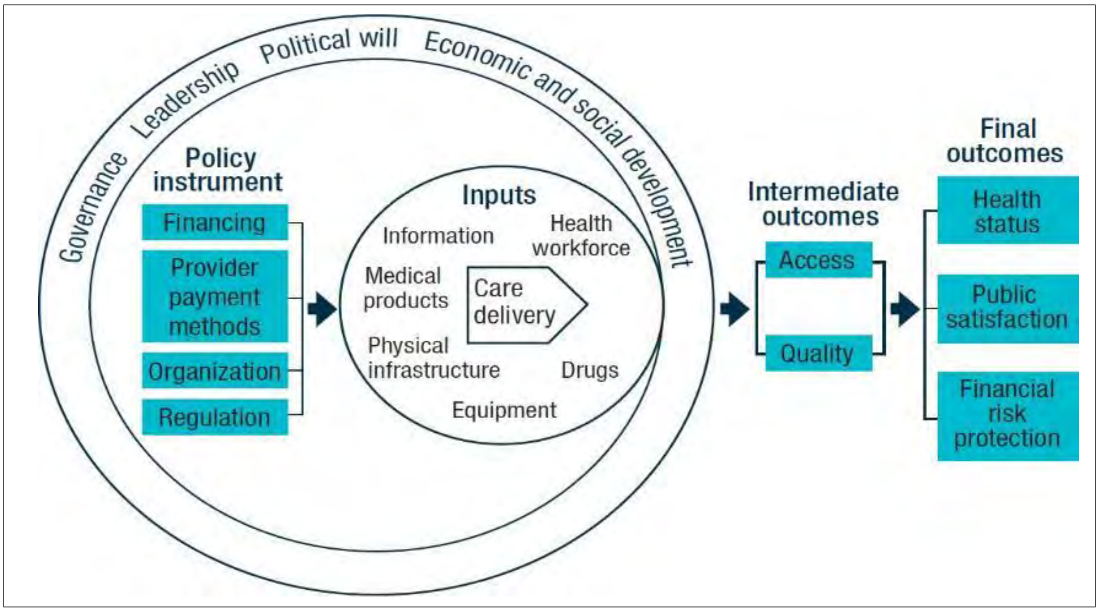


Figure 1: A systems framework for operational efficiency in a health-care system.

Source: Yip and Hafez (2015:6).

2. BACKGROUND

South African public health-care facilities are beset by vastly apparent barriers to the realization of strategic health outcomes. The framework depicted in Figure 2 provides a typical road map from organisational strategy to strategic outcomes, guided by organisational vision with strategic goals and often laden with barriers and enablers which widen or narrow the intervention-implementation gap, respectively. Failure to recognise and augment these enablers or "critical success factors" conjugately undermines their potential of narrowing the intervention-implementation chasm. This study is anchored on the development of a tool which assesses the status of the critical success factors which have the potential of narrowing the operational efficiency intervention-implementation gap.

Operational inefficiency derives from the sub-optimal processing of resource inputs in the health-care system and leads to poor performance of the organisation in terms of measurable health-care metrics and financial reports. Such inefficiency results from, *inter alia*, the mismatch between the genuine need (demand) for health-care services and the supply thereof (over- and under-utilisation); expenditure on items such as drugs, sundries, blood products and laboratory services; inappropriate admissions and prolonged average lengths of stay; deviation from prescribed treatment protocols and medicine formularies; negative incidents and clinical errors and hospital-acquired infections (Madubula, English, Padayachee and Mkhize, 2014).

Lean can be viewed as both a catalyst for interventions in an organisation on a continuous improvement journey and as an intervention itself which, through its tools and techniques, maximises service and production output with minimal resource inputs by eliminating waste and “doing better with less” (Improta, Romano, Di Cicco, Ferraro, Borrelli, Verdoliva and Cesarelli, 2018:1-2; Mayosi and Benatar, 2014:1351; Omogbai and Salonitis, 2016:106). The Lean Success Predictor for Rapid Initiation Tool (Lean ‘SPRInT’) is a tool for health-care managers to embark on the Lean transformation journey by assessing their hospitals’ status of CSFs for Lean initiation.

Lean SPRInT is characteristically different from scrum methodology in that scrum is described as a process framework under the umbrella of Agile with four specific events to optimise the work carried out by small teams: Sprint Planning, Daily Scrum, Sprint Review and Sprint Retrospective (Reddy, 2016; Sutherland and Schwaber, 2013:3). As indicated by Beck, Beedle, Bennekum, Cockburn, Cunningham, Fowler, Grenning, Highsmith, Hunt, Jeffries, Kern, Marick, Martin, Mellor, Schwaber, Sutherland and Thomas (2001), Agile is a philosophy documented in the Agile Manifesto, espousing specific values that contribute to flexible, change-adaptable and quick manufacturing of products. These values of Agile highlight the importance of team-member interactions, collaborations, and adaptability to change to produce products incrementally.

Scrum has been used since the early 1990s to manage complex product development such as software. The term “sprint”, in terms of the scrum framework is defined as a time period or time-box, usually 2 to 4 weeks, within which a potentially releasable product increment is created (Sutherland and Schwaber, 2013:3). A scrum sprint can be regarded as a project with a specific time frame that is not more than a month. Lean SPRInT is, accordingly, not in any way related to scrum sprint, and should not be confused with the methodology used in Agile Lean. Lean SPRInT is an acronym for an assessment tool that can be used by managers to assess the state of readiness for Lean implementation in hospitals.

Lean SPRInT could be used as an innovative means for the rapid but systematic initiation of Lean as a novel operations-management approach in public hospitals across KwaZulu-Natal. This could result in widespread adoption of the practice of Lean by health-care managers both in the public and private sectors nationwide. Successful Lean roll-out in turn facilitates the narrowing of the intervention-implementation gap for the realization of strategic goals. See Figure 2 for the intervention-implementation gap in the organisational strategy road map.

Figure 2: ***Intervention-implementation gap in the organisational strategy road map.***
Source: Author developed.

3. LITERATURE REVIEW

With the need for overhauling the health systems delivery platform in KwaZulu-Natal, the realization of the strategic priorities in its health transformation agenda has become ever more exigent (KZN Department of Health, 2018a, 2018b). Homing in on examples of operations or systems management priorities reflected in the KZN Department of Health's 2018-2019 Annual Performance Plan (Table 1), it is not unreasonable to deduce that a considerable portion of the KZN Department of Health priorities and goals are overtly in need of adroit managers with a sound management approach to be successfully addressed.

Against this backdrop, Lean is proposed as a contemporary approach to efficiently execute these systems management priorities. Research results show both successful and unsuccessful Lean implementation in various industries, indicating that CSFs for its initiation have to be recognised (Kundu, 2012:302). There is scarce empirical literature to guide how Lean implementation is operationalised in health care (Burgess and Radnor, 2013:220). There is limited evidence demonstrating the existence of tools for predicting at the outset the success of Lean initiation.

A seminal structure literature review of 177 research papers dating from 2000 to 2015 was conducted across several elements of health-care operations management, including service quality, service operations strategy, service scheduling, service performance and frontline employees (Jha, Sahay and Charan, 2016: 259-279). The literature review revealed that a large proportion of empirical studies has been conducted in developed nations (Jha *et al*., 2016: 271). This necessitates more health-care operations-management research in developing and underdeveloped countries due to the unique challenges experienced in these nations compared with the developed nations.

Table 1: Examples of KwaZulu-Natal Department of Health Operations or Systems Management-related Priorities 2018-2019.

KZN Department of Health Priorities	**Key focus areas and interventions (Operations or Systems Management-related items)**
Effective budget management	• Ensure cost containment and efficiency measures are in place and strictly adhered to
Improve patient waiting times	• Phased implementation of Centralised Chronic Medicines Dispensing and Distribution
Improve audit outcomes	• Supply Chain, Asset & Contract Management Strategy • Internal control and rigorous implementation & monitoring of the Audit Improvement Plan • Performance Information Improvement Plan • Financial management including Cost Containment Plan • Implement & monitor reviewed decentralised SCM, Financial and Human Resource delegations
Improve HR management	• Strengthen performance management & development
Improve management of performance information	• Implement strategy to improve record management • Rollout of web-based District Health Information System • Improve review and use of data at facility, sub-district & district level and improve the feedback system • Implement performance information management strategy • Implement the approved IT strategy including increasing broadband access at facility level
Manage finalisation and implementation of the integrated Turn-Around Plan	• Finalise the integrated Turn-Around Plan and manage and monitor implementation at all levels • Establish enabling environment for service delivery
Improve access, inequities, quality and efficiencies of District Hospitals	• Finalise the District Hospital Efficiency Study and use findings to inform the District Hospital Rationalisation Plan • Rationalisation including: Review referral systems & pathways; Redefine roles of Family Physicians in District Health System; and Complexing of identified facilities to ensure optimal utilisation of resources • Scale up implementation of National Core Standards • Strengthen Clinical Governance in all facilities
Implement strategy to reduce Medico-legal risks	• Finalise and implement the approved Medico-Legal Strategy & Implementation Plan
Reduce maternal mortality	• Improve safety at caesarean section delivery sites • Improve quality of antenatal, intrapartum and postnatal care
Reduce under 5 mortality	• Strengthen notification of deaths of children in hospital • Improve clinical audits of deaths • Strengthen Paediatric outreach through the District Clinical Specialist Teams
Improve storage medicine capacity at facilities	• Implement Direct Delivery System to facilities • Implement Cross Docking
Prevent medicine stock out, theft and abuse and wastage	• Automation of Expired Medication Alerts to improve stock management

Source: KZN Department of Health (2018a).

Evidence on the use of electronic tools for predicting the success of Lean initiation is lacking. It has been argued that existing Lean assessment tools provide qualitative analysis and do not provide any clear direction of where the improvement efforts should be directed (Srinivasaraghavan and Allada, 2006:1159). In addition, there is limited research on tools that assist with Lean deployment strategy elements (Machado Guimarães and Crespo de Carvalho, 2014:3-4). The assessment tools identified in reviewed literature do not offer any success predictor instrument for Lean implementation in hospitals.

4. ETHICS

Research ethics approval (HSS/0031/016D) was obtained from the Human Social Sciences Research Ethics Committee (HSSREC) at the University of KwaZulu-Natal (UKZN). Permission was also obtained from the KZN Department of Health's Provincial Health Research and Knowledge Management unit (KZ_2016RP31_475) and Deputy Director General for Specialised Services and Clinical Support. Informed consent was obtained from all participants. Permission was granted by Dr. Danie Vermaak for the use of his research questionnaire elements in the formulation of the data-collection tool for this study.

5. METHODOLOGY

The primary aim of this observational descriptive study which employed quantitative methods was to develop a Lean Success Predictor for Rapid Initiation Tool (Lean SPRInT) for the initiation of Lean in public hospitals across KwaZulu-Natal, South Africa.

5.1 Study site and sampling

The research was conducted across 73 public hospitals from a target population of 500 senior managers within the province of KZN. Simple random sampling was used.

For exploratory factor analysis, experts argue that the n:p ratio should be at least 3 to 6 subjects (n) per test item (p), set traditionally to a ratio of 5 to 1 but can be up to 20 to 1 (Kyriazos, 2018:2223; MacCallum, Widaman, Zhang and Hong, 1999:84-85; Schumacker and Lomax, 2015:240). A sample size of at least 192 (based on a subject: item ratio of 6:1) was required. The planned sample size of senior managers, considering a 5% margin of error and 95% confidence interval, was 218. In terms of the proposition by MacCallum *et al*. (1999:89) that the sample size can be judged acceptable if the communalities are high (squared multiple correlation > 0.6) and factors relatively few in number (3 factors in this study), the sample of 211 is reliable (MacCallum *et al*., 1999: 89).

5.2 Data collection and analysis

A self-administered, semi-structured questionnaire with mixed categorical, open-ended and variable Likert-scale questions was used for data collection. Cronbach's alpha was used to determine the internal consistency of the test items, looking particularly for homogeneity of items measuring latent constructs (Faith, Kim and Heo, 2015:2). Cronbach's alpha generally >0.7 was considered acceptable (Bujang, Omar and Baharum, 2018:88-89; Taber, 2018:1278, 1288). Cronbach's alpha for this study is reflected in Table 2. Data was reduced using EFA to identify latent constructs. Confirmatory factor analysis (CFA) was used to determine the reliability and validity (both convergent and discriminant) of these factors. Structural equation modelling (SEM) fit indices were then applied to assess acceptability of the measurement model.

6. RESULTS

The participant response rate was 96.8% (n=211). The results of the Likert scale ratings were used to identify three CSFs after several iterations of EFA.

6.1 Validity and Reliability of Model

The following conditions are required for reliability and validity of the model:

- Reliability: Composite Reliability (CR) > 0.7 and loadings on factors > 0.5
- Convergent validity: CR > Average Variance Extracted (AVE) and AVE > 0.5
- Discriminant validity: AVE > squared correlations

For this model, Table 2 shows the values of the indices used to assess for reliability and validity, based on the conditions specified above. Diagonals represent AVE, and Alpha represents Cronbach's alpha reliability measure. Off diagonals represent squared correlations (also known as shared variance).

Table 2: Squared Correlations, Composite Reliability, Average Variance Extracted and Cronbach's Alpha for Current Model.

	Squared correlations				
Construct	**Factor 1**	**Factor 2**	**Factor 3**	**CR**	**Cronbach's Alpha**
Factor 1	0.632			0.932	0.934
Factor 2	0.484	0.639		0.775	0.715
Factor 3	0.619	0.576	0.631	0.773	0.763

Source: Author developed.

All reliability and validity conditions have been met, thus rendering the model reliable and valid.

6.2. Critical Success Factors for Lean Initiation

Critical Success Factors (CSF) is defined as "the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organisation" (Rockart, 1979:85). Three CSFs for the successful initiation of Lean in South African public hospitals have been identified. Each CSF consists of elements which itemise the factor (see Table 3). The elements of each factor provide a brief statement of the key requirements for health-care managers to consider prior to the initiation of Lean in public hospitals, the absence of which may impede successful Lean roll-out.

Table 3: Critical Success Factors for Lean Initiation in Hospitals.

Critical Success Factors	Elements (taken from test items)
CSF 1: Strategic Leadership and Organisational Attitude	L1: Leadership at all levels in the organisation must drive, live and demonstrate Lean behaviour.
	A2: An organisation implementing Lean must face and embrace the various attitudinal aspects of Lean. S1: Lean philosophy and principles must be reflected in the organisation's business strategy.
	L2: Lean leadership leads to Lean thinking.
	S3: Lean implementation must be driven as a high priority strategic business initiative.
	L4: The difference between Lean success and failure starts with leadership.
	A1: The mind-set and attitude or behaviour of people is fundamental to Lean success.
	S2: There must be a clear link between the organisation goals, key objectives and Lean activities.
CSF 2: Integration of Lean elements, tools and techniques	I4: The organisation must use all of the goals, methods, techniques and foundation elements of Lean in combination
	T4: The application of Lean tools and techniques will ensure Lean success.
CSF 3: Basic stability in operational processes	T3: It is important to understand the organisation's processes and only apply the Lean tools and techniques applicable to that specific process type.
	B4: Stability in operating systems is a pre-requisite for Lean transformation.

Source: Author developed.

7. DISCUSSION

7.1 Development of the Lean SPRInT

The three CSFs identified through factor analysis and SEM are considered robust predictors of indicating success of Lean initiation in hospitals as all reliability and validity conditions have been met. The Lean SPRInT is a user-friendly success prediction instrument that can be used as a yardstick for health-care managers to ascertain in advance the state of readiness of public hospitals for Lean initiation. It was developed from the three CSFs which have been integrated into an electronic tool. Lean SPRInT captures managers' inputs and produces readiness ratings and guidance processes for successful Lean initiation.

Lean SPRInT version 1.0 currently uses a Microsoft® Excel platform and user interface. Demographics and user details are captured on the landing screen (Figure 3). For public hospitals in KZN, there is a drop-down menu from which to select a hospital name., The hospital classification and its number of beds is displayed automatically from a back-end database.

Thereafter the user switches over to the Lean success predictor input screen (Figure 4). Each CSF element formed the backbone of the Lean SPRInT success predictor input interface. The Lean success predictor input screen requires the user to select ratings from a drop-down menu, based on a Likert scale ("strongly agree"=4, "agree"=3, "disagree"=2 and "strongly disagree"=1), for each element as an indication of their degree of existence or applicability to their organisation's current environment in terms of Lean readiness. See Figure 3 for Lean SPRInT landing screen for input of demographic and user details.

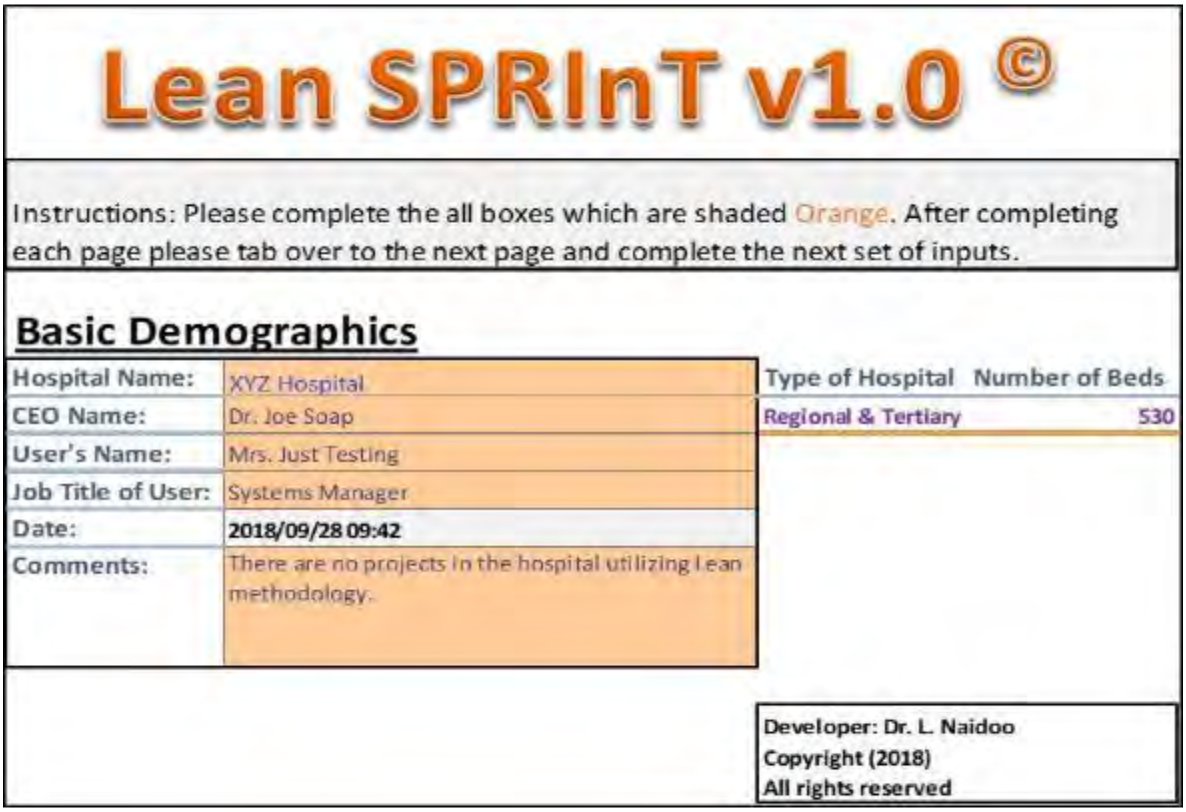
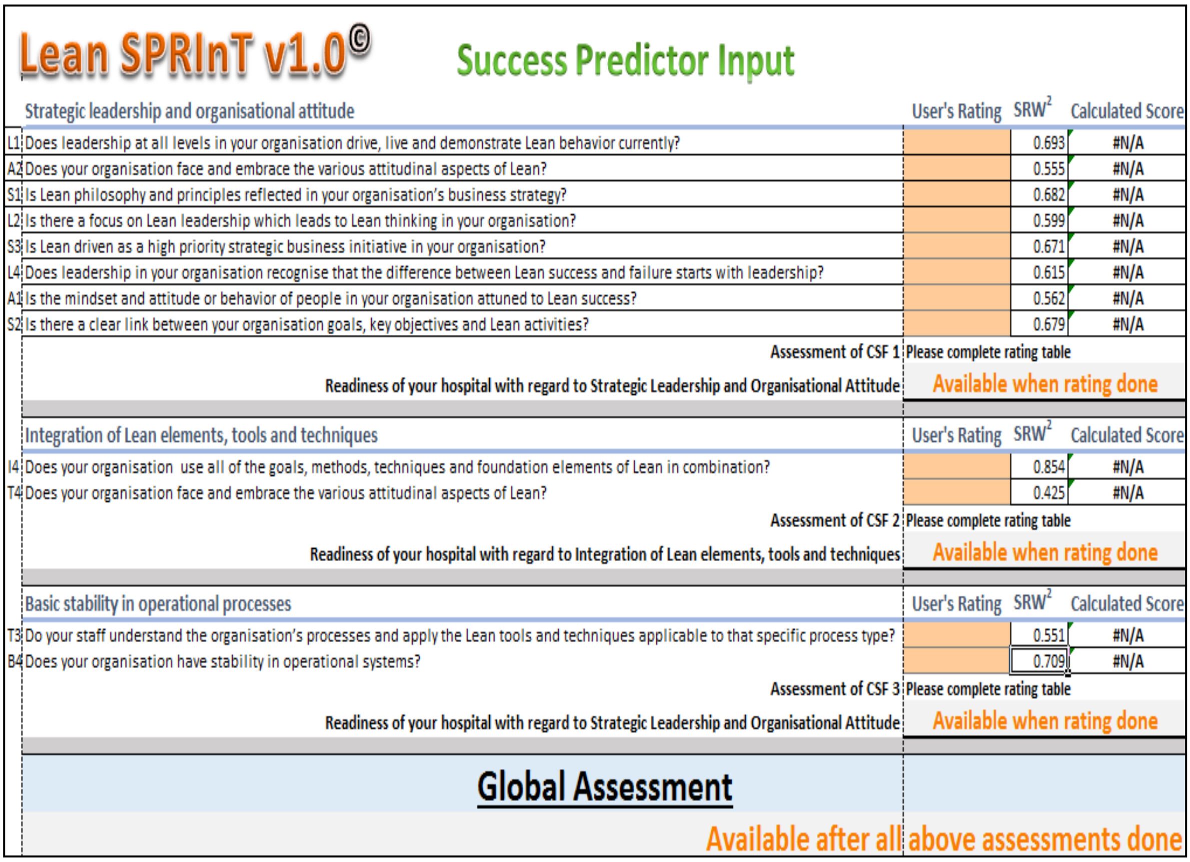


Figure 3: Lean SPRInT landing screen for input of demographic and user details.

Source: Author developed.

See Figure 4 for Lean SPRInT success predictor input screen.

Figure 4: Lean SPRInT Success Predictor Input Screen.



Lean SPRInT v1.0© Success Predictor Input

	Strategic leadership and organisational attitude	User's Rating	SRW^2	Calculated Score
L1	Does leadership at all levels in your organisation drive, live and demonstrate Lean behavior currently?		0.693	#N/A
A2	Does your organisation face and embrace the various attitudinal aspects of Lean?		0.555	#N/A
S1	Is Lean philosophy and principles reflected in your organisation's business strategy?		0.682	#N/A
L2	Is there a focus on Lean leadership which leads to Lean thinking in your organisation?		0.599	#N/A
S3	Is Lean driven as a high priority strategic business initiative in your organisation?		0.671	#N/A
L4	Does leadership in your organisation recognise that the difference between Lean success and failure starts with leadership?		0.615	#N/A
A1	Is the mindset and attitude or behavior of people in your organisation attuned to Lean success?		0.562	#N/A
S2	Is there a clear link between your organisation goals, key objectives and Lean activities?		0.679	#N/A
	Assessment of CSF 1	Please complete rating table		
	Readiness of your hospital with regard to Strategic Leadership and Organisational Attitude	Available when rating done		
	Integration of Lean elements, tools and techniques	User's Rating	SRW^2	Calculated Score
I4	Does your organisation use all of the goals, methods, techniques and foundation elements of Lean in combination?		0.854	#N/A
T4	Does your organisation face and embrace the various attitudinal aspects of Lean?		0.425	#N/A
	Assessment of CSF 2	Please complete rating table		
	Readiness of your hospital with regard to Integration of Lean elements, tools and techniques	Available when rating done		
	Basic stability in operational processes	User's Rating	SRW^2	Calculated Score
T3	Do your staff understand the organisation's processes and apply the Lean tools and techniques applicable to that specific process type?		0.551	#N/A
B4	Does your organisation have stability in operational systems?		0.709	#N/A
	Assessment of CSF 3	Please complete rating table		
	Readiness of your hospital with regard to Strategic Leadership and Organisational Attitude	Available when rating done		
	Global Assessment			
	Available after all above assessments done			

Source: Author developed.

At the back end of Lean SPRInT, the squared multiple correlations (communalities) or squares of the standardised regression weights (SRW^2) are used as weights for each of the elements in the input interface. These weights, together with the users input ratings (1 to 4), generate products (calculated scores) for each element, i.e., user rating x SRW^2. Figures 5, 6 and 7 show examples of simulated user inputs, SRW^2 (weights), and calculated scores for CSF 1, CSF 2 and CSF 3 elements, respectively.

	Strategic leadership and organisational attitude	User's Rating	SRW^2	Calculated Score
L1	Does leadership at all levels in your organisation drive, live and demonstrate Lean behaviour currently?	Agree	0.693	**2.079**
A	Does your organisation face and embrace the various attitudinal aspects of Lean?	Agree	0.555	**1.665**
S1	Is Lean philosophy and principles reflected in your organisation's business strategy?	Strongly Agree	0.682	**2.728**
L2	Is there a focus on Lean leadership which leads to Lean thinking in your organisation?	Strongly Disagree	0.599	**0.599**
S3	Is Lean driven as a high priority strategic business initiative in your organisation?	Strongly Agree	0.671	**2.684**
L4	Does leadership in your organisation recognise that the difference between Lean success and failure starts with leadership?	Strongly Agree	0.615	**2.46**
A	Is the mindset and attitude or behaviour of people in your organisation attuned to Lean success?	Strongly Agree	0.562	**2.248**
S2	Is there a clear link between your organisation goals, key objectives and Lean activities?	Disagree	0.679	**1.358**

Figure 5: Simulated user inputs, SRW2 (weights) and calculated scores for CSF 1 elements.
Source: Author developed.

Integration of Lean elements, tools and techniques	User's Rating	SRW^2	Calculated Score
Does your organisation use all of the goals, methods, techniques and foundation elements of Lean in combination?	Strongly Agree	0.854	**3.416**
Does your organisation face and embrace the various attitudinal aspects of Lean?	Strongly Disagree	0.425	**0.425**

Figure 6: Simulated user inputs, SRW2 (weights) and calculated scores for CSF 2 elements.
Source: Author developed.

Basic stability in operational processes	User's Rating	SRW^2	Calculated Score
Do your staff understand the organisation's processes and apply the Lean tools and techniques applicable to that specific proc	Strongly Agree	0.551	**2.204**
Does your organisation have stability in operational systems?	Agree	0.709	**2.127**

Figure 7: Simulated user inputs, SRW2 (weights) and calculated scores for CSF 3 elements.

Source: Author developed.

The maximum calculated score for each element is the product of 4 (maximum possible user rating) and the SRW^2 for that element, whereas the minimum calculated score is the product of 1 (minimum possible user rating) and the SRW^2 for that element. The sum of the maximum calculated scores for the elements of a particular CSF provides the maximum calculated score for that CSF. Likewise, the sum of the minimum calculated scores for the elements of a particular CSF provides the minimum calculated score for that CSF.

The overall range of scores for a CSF is divided equally into three sub-categories or tripartite ranges which correlate with a particular Lean readiness level (1, 2 or 3) for that CSF. The Lean readiness level for a CSF is then determined by placing the total calculated score for a particular CSF within one of the tripartite ranges for that CSF

(Table 4). The overall range of scores for the final prediction of Lean readiness for the organisation is also divided equally into three subcategories (Table 4) which correlate with an organisational Lean readiness level (1, 2 or 3).

Table 4: Minimum and maximum scores for the different Lean readiness levels in terms of the three CSFs and the overall total score.

		Category	**Minimum score (1x SRW²)**	**Maximum score (4x SRW²)**	**Readiness levels**
Scores for Total	7.595-15.19	Total	7,595	15,19	Readiness level 1
	15.20-22.785	Total	15,2	22,785	Readiness level 2
	22.786-30.38	Total	22,786	30,38	Readiness level 3
Scores for CSF1	5.056-10.112	CSF1	5,056	10,112	Readiness level 1
	10.113-15.168	CSF1	10,113	15,168	Readiness level 2
	15.169-20.224	CSF1	15,169	20,224	Readiness level 3
Scores for CSF2	1.279-2.558	CSF2	1,279	2,558	Readiness level 1
	2.559-3.837	CSF2	2,559	3,837	Readiness level 2
	3.838-5.116	CSF2	3,838	5,116	Readiness level 3
Scores for CSF3	1.26-2.52	CSF3	1,26	2,52	Readiness level 1
	2.53-3.78	CSF3	2,53	3,78	Readiness level 2
	3.79-5.04	CSF3	3,79	5,04	Readiness level 3

Source: Author developed.

Lean SPRInT's output screen (Figure 8) with calculated Lean readiness levels, ranging from 1 to 3 (most unfavourable to most favourable prediction of readiness, respectively), is supplemented by commentary and recommendations to the user. These recommendations succinctly provide managers with a practical conduit to deploy resources without having to embark on the Lean journey blindly. This ensures that the ultimate aim of Lean SPRInT to determine upfront the state of Lean readiness is met by managers capturing inputs and the tool producing readiness ratings and recommendations for successful Lean initiation.

The culmination of the research in a tool that is both user-friendly and simple to use by health-care managers wanting to introduce Lean in their institutions augurs well for the Lean body of knowledge.

Lean SPRInT v1.0© **Success Predictor Input**

	Strategic leadership and organisational attitude	User's Rating	SRW^2	Calculated Score
L1	Does leadership at all levels in your organisation drive, live and demonstrate Lean behavior currently?	Agree	0.693	2.079
A2	Does your organisation face and embrace the various attitudinal aspects of Lean?	Disagree	0.555	1.11
S1	Is Lean philosophy and principles reflected in your organisation's business strategy?	Strongly Agree	0.682	2.728
L2	Is there a focus on Lean leadership which leads to Lean thinking in your organisation?	Strongly Agree	0.599	2.396
S3	Is Lean driven as a high priority strategic business initiative in your organisation?	Agree	0.671	2.013
L4	Does leadership in your organisation recognise that the difference between Lean success and failure starts with leadersh	Agree	0.615	1.845
A1	Is the mindset and attitude or behavior of people in your organisation attuned to Lean success?	Strongly Disagre	0.562	0.562
S2	Is there a clear link between your organisation goals, key objectives and Lean activities?	Strongly Agree	0.679	2.716
	Assessment of CSF 1	15.449		
	Readiness of your hospital with regard to Strategic Leadership and Organisational Attitude	Readiness level 3		
	Integration of Lean elements, tools and techniques	User's Rating	SRW^2	Calculated Score
I4	Does your organisation use all of the goals, methods, techniques and foundation elements of Lean in combination?	Disagree	0.854	1.708
T4	Does your organisation face and embrace the various attitudinal aspects of Lean?	Agree	0.425	1.275
	Assessment of CSF 2	2.983		
	Readiness of your hospital with regard to Integration of Lean elements, tools and techniques	Readiness level 2		
	Basic stability in operational processes	User's Rating	SRW^2	Calculated Score
T3	Do your staff understand the organisation's processes and apply the Lean tools and techniques applicable to that specifi	Strongly Agree	0.551	2.204
B4	Does your organisation have stability in operational systems?	Strongly Agree	0.709	2.836
	Assessment of CSF 3	5.04		
	Readiness of your hospital with regard to Strategic Leadership and Organisational Attitude	Readiness level 3		
	Global Assessment	23.472		
	Grey's Hospital: Readiness level 3			

Figure 8: Lean SPRInT simulated inputs.

Source: Author developed.

7.1 Roll-out of the Lean SPRInT

It is envisaged that Lean SPRInT could be adopted by the South African Department of Health, starting with the provincial hospitals in KZN, to assess the state of readiness for Lean initiation. The proposed 6 steps for the deployment of Lean SPRInT prior to the initiation of Lean in public hospitals are represented in Figure 9.

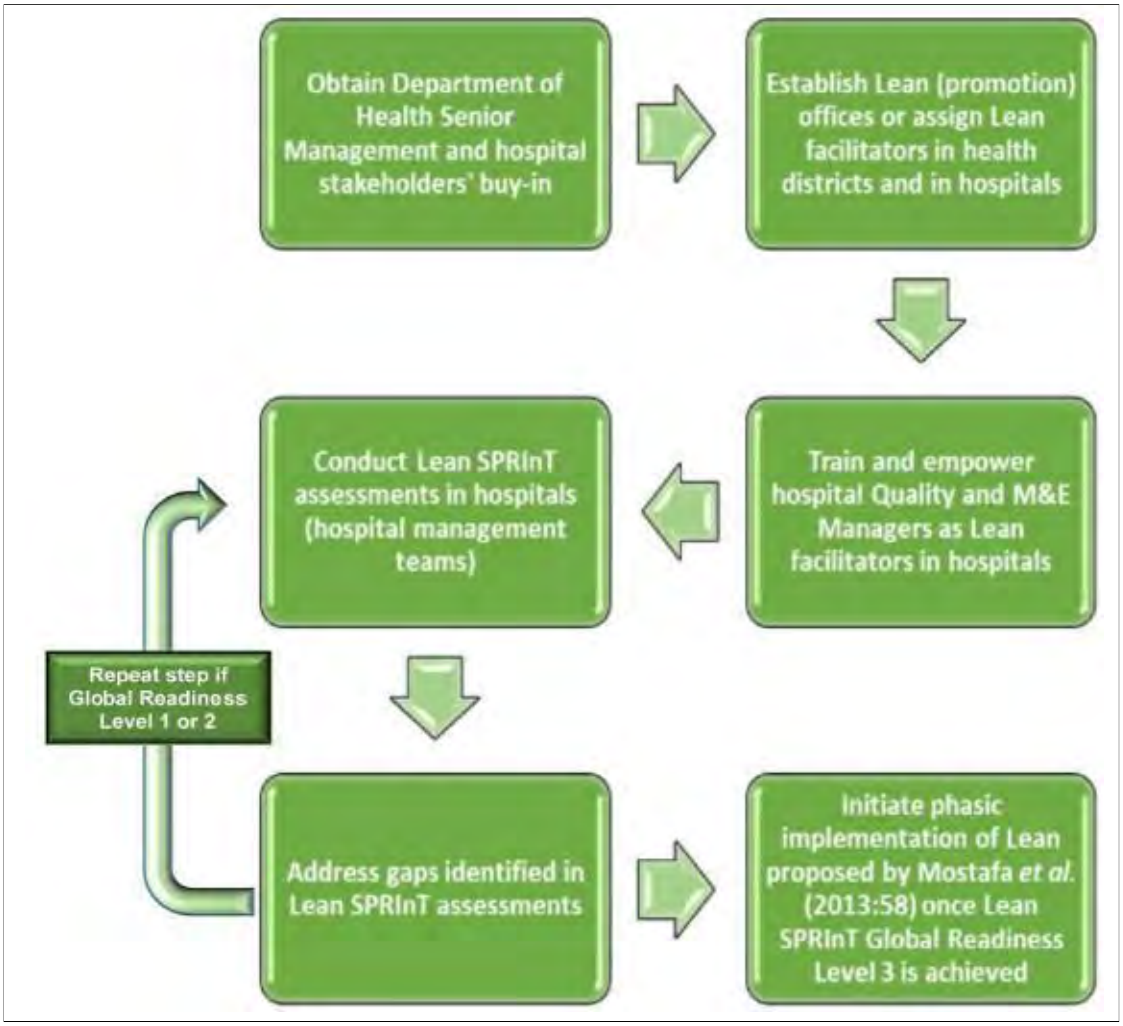


Figure 9: Six steps for the deployment of Lean SPRInT prior to Lean initiation in public hospitals.

Source: Author developed.

The foremost step involves obtaining buy-in from the KZN Head of Health and top management, and subsequently meeting with the district and hospital managers to introduce the tool and its purpose.

As the second step, the possibility of allocating a Lean (promotion) office as a Lean "helpdesk" in every health district should be considered. This office would be responsible for guiding hospitals within their jurisdiction on the use of Lean SPRInT. This office must place focus on “how to stay” rather than “how to be” Lean in order to avoid hospitals returning to their previous comfort zones after Lean roll-out (Freitas, Freitas, Gomes de Menezes and Odorczyk, 2018; Machado Guimarães and Crespo de Carvalho, 2014: 7). Lean (promotion) offices in health districts can be a shared resource for hospitals rolling out Lean; and could be incorporated into existing district monitoring and evaluation (M&E) management or quality management offices (Freitas *et al.*, 2018; Goehnera, Mello and Bandeira, 2016: 39).

The third step is training of key staff, such as quality and M&E managers at hospital level, on the Lean SPRInT. This is a crucial step as it supports the maintenance and promotion of Lean at the coalface. According to the World Health Organisation (2007), “good leadership and management are about providing direction to, and gaining commitment from, partners and staff, facilitating change and achieving better health services through efficient, creative and responsible deployment of people and other health resources” (Doherty, 2013:7; World Health Organisation, 2007:1). Doherty (2013:9) cites the theory of “street-level bureaucrats”, who, in health facilities, are the front-line workers such as doctors and nurses with direct patient and family contact, and make decisions on a daily basis at the ‘coalface’ on resource deployment and health-care options which affect the performance of the institution. The degree of clinical leadership demonstrated in these “street-level bureaucrats” inevitably influences the operational efficiency at which the organisation performs.

Considering the above, training on the deployment of Lean SPRInT must target key stakeholders from hospitals, including quality and M&E managers and front-line clinician leaders. Hospital quality or M&E managers could be assigned as Lean facilitators within the hospitals. The training could include serial workshops on the functional and technical aspects of Lean SPRInT, interpretation of the outputs of Lean SPRInT, and the possible options to consider as next steps for achieving Lean readiness. Lean experts from the Lean Institute of Africa could be invited to facilitate these workshops jointly with the developer of Lean SPRInT.

The fourth step is the actual application of the Lean SPRInT. It is proposed that the tool be completed by a joint sitting of top management of the hospital. It is imperative that the key managers assign, through consensus, ratings for each of the CSF elements in the tool. In step 5, gaps identified in terms of not meeting the CSF criteria for readiness of Lean initiation must be addressed, preferably through a formal action plan with activities and responsible persons for carrying out these activities within strict time frames. The Lean SPRInT must then be applied iteratively and periodically in a follow-up sitting of top management to assess progress made in addressing the initial gaps identified. Only once a global readiness level of 3 is achieved should the initiation of Lean be considered (Step 6). It is posited that implementation frameworks have highest success rates for Lean initiation (Mostafa, Dumrak and Soltan, 2013:60). Although the output of Lean SPRInT does not consider sequenced Lean implementation, it is advisable that a phasic approach for Lean initiation is followed in Step 6 (Mostafa *et al*., 2013:54-60). A useful model is depicted in Figure 10, in which Lean implementation commences with a conceptual phase, then moves to an implementation design phase, an implementation and evaluation phase, and finally a complete Lean transformation phase.

It has been suggested that unified efforts of clinical and non-clinical services in health-care facilities, decentralised clinical and managerial decision-making and culture transformation are more likely to lead to better outcomes (Doherty, 2013:35). Lean fosters these characteristics, and if effectively inculcated in and practised by leaders at all levels within health-care institutions, it is likely to lead to improvement in operational efficiency, thus narrowing the strategy intervention-implementation gap depicted in Figure 2.

See Figure 10 for the proposed framework for phasic Lean implementation.

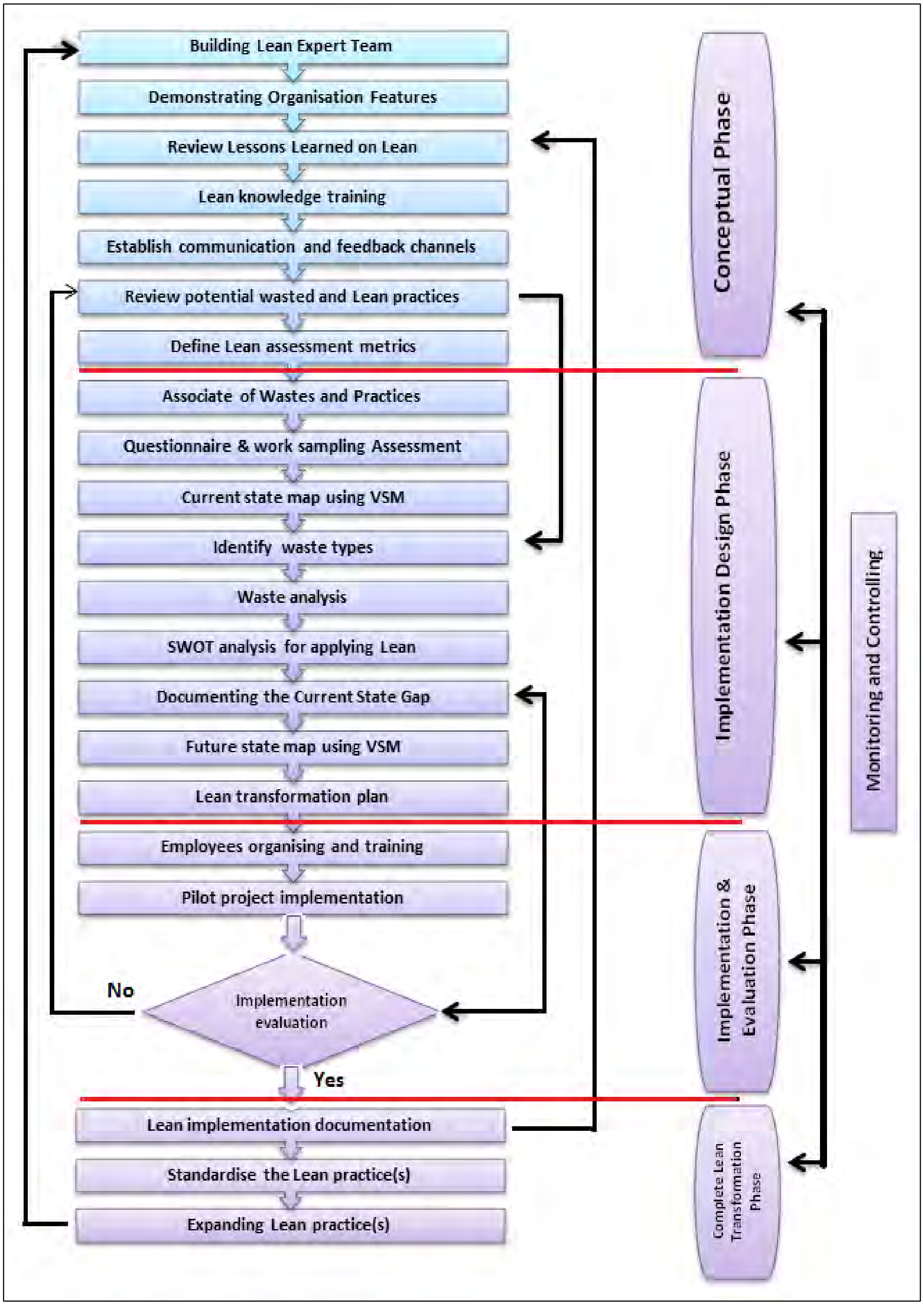


Figure 10: ***A proposed framework for phasic Lean implementation.***

Source: Mostafa *et al*. (2013:58).

7.2 Monitoring the Implementation of Lean

The success of Lean implementation is also determined by its monitoring and controls to prevent slippage. Lean SPRInT is not a monitoring tool as it does not assess the degree of improvements made nor the pitfalls during Lean implementation. The healthcare lean assessment tool (HLA) has been proposed as a useful monitoring instrument for providing a current-state diagnosis of the implementation process along the different Lean maturity levels, thus guiding the Lean journey (Machado Guimarães and Crespo de Carvalho, 2014:15-21). As Lean transformation matures from Lean initiation, with intertwining training on soft (human aspects) and hard skills (Lean tools and techniques), the hospital would proceed through four stages as depicted in Figure 11. Lean SPRInT would precede Stage 1.

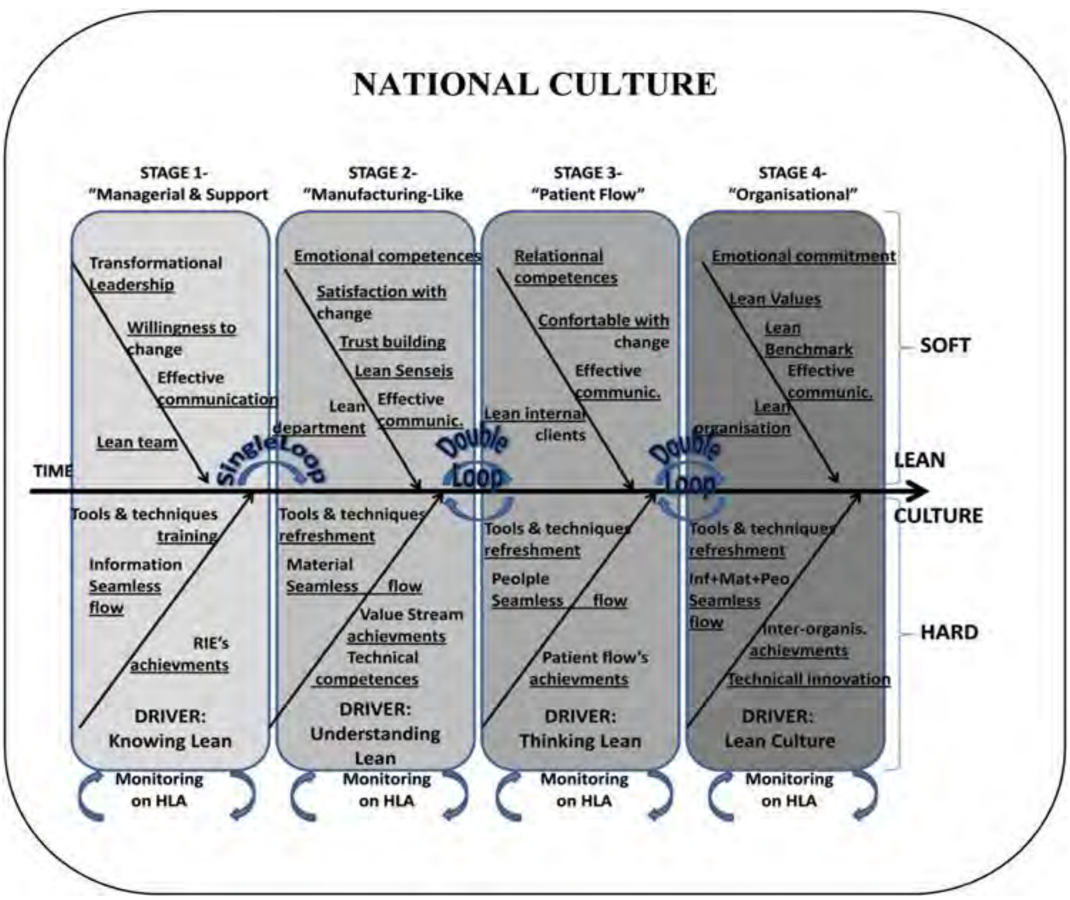


Figure 11: Lean maturity model in healthcare organisations.

Source: Machado Guimarães and Crespo de Carvalho (2014: 8).

The HLA tool is based on the Shingo transformational model known as the Shingo diamond (Figure 12), which reinforces a systematic approach to ongoing improvement (Machado Guimarães and Crespo de Carvalho, 2014:14). The Shingo diamond demonstrates the interrelationship amongst guiding principles, systems, tools, and results, all of which effectively influence the culture of the organisation. The HLA tool assesses whether each process in the maturity model (Figure 11) should be improved, disrupted, or eliminated; and can be used as an ongoing implementation assessment, providing control measures and corrective actions.

Figure 12: The Shingo transformational model.
Source: Shingo Institute (2018).

8. MANAGEMENT IMPLICATIONS

Lean SPRInT's output of calculated Lean readiness levels for each of the CSF elements allows managers to gauge the deficiencies in their institution, which, once improved, would portend a more favourable prediction of success. Lean SPRInT as a success predictor instrument is by no means the panacea for Lean implementation in hospitals, but prepares managers embarking on a Lean journey by providing them with a current-state assessment of their organisation in terms of the elements of the 3 CSFs. The use of Lean SPRInT should be integrated in a phasic Lean implementation framework, such that the assessment outputs will facilitate appropriate resource deployment as the Lean journey progress from one phase to the next.

9. AREAS FOR FUTURE RESEARCH

Future research to evaluate the effectiveness and practicality of Lean SPRInT is recommended. Research on the utilization or uptake of Lean SPRInT in public hospitals, and correlation of the findings with the successful initiation of Lean will be useful in determining the value of the tool. A survey on the attitudes and perceptions of senior managers regarding Lean SPRInT will provide useful information for the developer to consider in refining the tool.

10. LIMITATIONS OF THE STUDY

The researcher experienced difficulty in reaching the target population and delayed response times owing to the geographical spread of the public hospitals, some with information technology and network difficulties. There were also some management posts that were vacant with high staff turnover rate, often with people erratically acting in those positions. Most of these limitations were addressed by close follow-up with the local health district offices and district quality and information managers, which support respective hospitals. A research assistant was also used to distribute and collect questionnaires and to follow up responses from participants.

11. CONCLUSIONS

The organisational strategy road map is guided by strategic vision and goals and is often laden with barriers and enablers which widen or narrow the intervention-implementation gap, respectively. Lean is both a catalyst for interventions and an intervention itself which maximises output with minimal resource inputs by “doing better with less” (Omogbai and Salonitis, 2016:106; Røvik and Andersen, 2015:1; Womack *et al*., 2007:1). The Lean SPRInT is proposed as a management tool for assessing hospitals’ readiness status for Lean initiation prior to embarking on a Lean transformation journey.

Lean SPRInT utilises a scoring system for assessing the degree of readiness for Lean initiation in accordance with three critical success factors (CSFs): (1) Strategic leadership and organisational attitude; (2) Integration of Lean elements, tools and techniques, and (3) Basic stability in operational processes. The culmination of this study in a tool that is both user-friendly and simple to use by managers wanting to initiate Lean in their hospitals augurs well for the Lean body of knowledge.

A six-step process for the deployment of Lean SPRInT in public hospitals is proposed in this article. Top management buy-in precedes the establishment of Lean promotion offices and/or facilitators using existing resources such as quality and M&E managers as shared resources within health districts. Empowerment of these officials through training is essential. Lean SPRInT assessments of hospitals must be carried out by hospital management teams, facilitated by quality and M&E managers, and identified gaps addressed through a structured approach. Lean SPRInT assessments and addressing shortfalls are repeated in an iterative process until the tool predicts a global readiness level of 1, heralding the readiness to proceed with Lean initiation. A phasic approach for Lean implementation, together with close monitoring to prevent slippage using the HLA tool is recommended.

It is suggested that unified efforts of clinical and non-clinical services in health-care facilities, decentralised clinical and managerial decision-making and culture transformation are more likely to lead to better outcomes of Lean initiation (Doherty, 2013:35). Such an approach is likely to sustainably improve operational efficiency and narrow the strategic intervention-implementation gap for successfully achieving targeted health outcomes.

12. COMPETING INTERESTS

None.

13. AUTHORS' CONTRIBUTIONS

Logandran Naidoo conducted the research and produced the report. Ziska Fields supervised the research.

14. ACKNOWLEDGEMENTS

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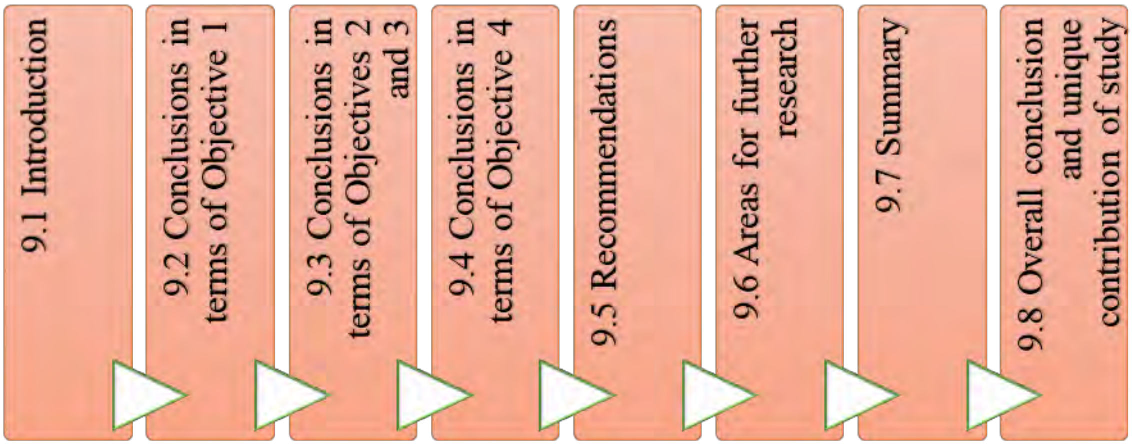
8.3 Conclusion

The Lean SPRInT is proposed as a management tool for assessing hospitals' readiness status for Lean initiation prior to embarking on a Lean transformation journey. In this chapter and corresponding article, the wide-scale deployment of Lean in KZN Department of Health hospitals is described. Lean SPRInT utilises a scoring system for assessing the degree of readiness for Lean initiation in accordance with three critical success factors (CSFs): (1) Strategic leadership and organisational attitude; (2) Integration of Lean elements, tools and techniques, and (3) Basic stability in operational processes. The culmination of this study in a tool that is both user-friendly and simple to use by managers wanting to initiate Lean in their hospitals augurs well for the Lean body of knowledge.

A six-step process for the deployment of Lean SPRInT in public hospitals is proposed in this article. Top management buy-in precedes the establishment of Lean promotion offices and/or facilitators using existing resources such as quality and M&E managers as shared resources within health districts. Empowerment of these officials through training is essential. Lean SPRInT assessments of hospitals must be carried out by hospital management teams, facilitated by quality and M&E managers, and identified gaps addressed through a structured approach. Lean SPRInT assessments and addressing shortfalls are repeated in an iterative process until the tool predicts a global readiness level of 1, heralding the readiness to proceed with Lean initiation. A phasic approach for Lean implementation, together with close monitoring to prevent slippage using the HLA tool is recommended.

It is suggested that unified efforts of clinical and non-clinical services in health-care facilities, decentralised clinical and managerial decision-making and culture transformation are more likely to lead to better outcomes of Lean initiation (Doherty, 2013). Such an approach is likely to sustainably improve operational efficiency and narrow the strategic intervention-implementation gap for successfully achieving targeted health outcomes.

9. CHAPTER NINE: CONCLUSION AND RECOMMENDATIONS



9.1 Introduction

The question of how operations- or systems-related priorities in the KZN Department of Health are tackled in a systematic approach has been only marginally described in literature (KZN Department of Health, 2014, 2017, 2018a). This research contributed substantially to the Lean body of knowledge by addressing the above paucity in existing literature. The key research question that had to be answered was: What are the critical success factors that will predict the success of Lean initiation in public hospitals in KwaZulu-Natal, South Africa? The sub-questions which the research findings addressed were:

- What is the current knowledge, experience, and perception of Lean amongst senior health-care managers in public hospitals in KwaZulu-Natal?
- What are the key variables for the expeditious and successful initiation of Lean in public hospitals across KwaZulu-Natal?
- How can factor analysis and structural equation modelling (SEM) be applied to the key variables to identify critical success factors which predict the successful initiation of Lean?
- In which ways can the critical success factors be used to develop a practical, electronic Lean initiation success predictor tool (Lean SPRInT)?

The fundamental aim of the research was to develop a Lean success predictor tool (Lean SPRInT) for the initiation of Lean in public hospitals across KwaZulu-Natal, South Africa. The research therefore met the following four objectives as initially planned:

1. To describe the knowledge, experience, and perceptions of Lean amongst senior health-care managers in public hospitals in KwaZulu-Natal;
2. To identify the key variables for the successful initiation of Lean in public hospitals in KwaZulu-Natal;
3. To conduct factor analysis and structural equation modelling (SEM) on the key variables leading to the identification of critical success factors for Lean initiation; and
4. To utilise these critical success factors, and develop a lean success predictor for rapid initiation tool (Lean SPRInT) for the successful initiation of Lean.

This chapter concludes this thesis by highlighting the key findings in terms of the research questions and objectives. It provides recommendations for the KZN Department of Health and other relevant stakeholders to advance the application of the identified CSFs using Lean SPRInT.

9.2 Conclusions (in terms of Objective 1): Current Knowledge and Experience of Lean Amongst Senior Health-care Managers

The level of knowledge of, and practical experience with Lean and its tools and techniques is very low amongst senior health-care managers in public hospitals in KZN. The approximately one-third of managers who had heard of Lean admitted that their level of knowledge was significantly low. Managers with more than 10 years of experience in the health sector had some pre-existing knowledge of and interest in Lean, suggesting that the organisation should capitalise on such a cadre of enthusiastic managers for Lean implementation.

A number of the Lean tools and techniques which may also be used in any project or activity independent from other Lean methods, such as PDCA, 5-Why, 5-S and A3 chart, are the most commonly known to senior managers in the province. Focus should be placed on enhancing the use of these tools and techniques as part of Lean implementation within the organisation. Other tools and techniques, such as andons and *kanbans*, should be taught through formal Lean training programmes within the organisation.

The organisation's overall current approach to Lean in terms of Petterson's model lies within the 'Toolbox Lean' quadrant (Pettersen, 2009). This places the organisation as having a basic level of Lean implementation with sporadic and infrequent application of Lean tools and techniques on a small scale across the management gamut. This classification suggests that the organisation would benefit from critical success factors for Lean initiation to raise the degree of Lean industriousness to 'Lean thinking' in Petterson's (2009) model.

A large majority (91.9%) of managers, more especially those who had heard about Lean, indicated that they would be interested in learning more about Lean. Managers also strongly felt that there was an opportunity for adopting Lean practices and for applying tools and techniques which could possibly improve the operational performance of their hospitals. Considering this interest in Lean application, the senior managers working in all public hospitals in KZN would be ideally placed for training on Lean, involving them in the implementation of Lean.

9.3 Conclusions (in terms of Objectives 2 and 3): Key Variables and Critical Success Factors which Predict the Successful Initiation of Lean in Public Hospitals

Applying exploratory factor analysis, confirmatory factor analysis, and structural equation modelling, three CSFs for the initiation of Lean in public hospitals were identified. CSF 1 (Strategic leadership and organisational attitude), CSF 2 (Integration of Lean elements, tools and techniques) and CSF 3 (Basic stability in operational processes) are key requisites for managers to consider prior to the initiation of Lean.

The literature depicts collaborative leadership and the entrenching of Lean as a strategic driver as an important facilitator of and success factor for Lean in several industries. This study corroborates CSF 1 as a fundamental factor for Lean implementation success also within the health-care industry. The study highlights CSF 2 and CSF 3 for Lean implementation in KZN public hospitals as having more credence than the lower emphasis placed on similar factors described in reviewed literature. These two CSFs are justified by the application of the five Lean principles as integral rudiments for successful Lean initiation in the health-care industry.

The three CSFs must not be viewed in isolation, as they each have significant implications at different capability dimensions within an organisation (Andersen *et al.*, 2014). The application of the CSFs and the content, context, use and results of Lean should be viewed in the light of the organisation's technical, strategic, cultural, and structural environment (Andersen *et al.*, 2014). The identified CSFs formed the mainstay for the development of the Lean success predictor for rapid initiation tool ('Lean SPRInT') which is proposed as a Lean initiation and contextual baseline and readiness assessment tool for public hospitals in KwaZulu-Natal.

The Lean SPRInT will be propositioned as a launch tool for health-care managers to embark on the Lean transformation journey. Lean SPRInT employs the elements of the three identified CSFs for Lean initiation which, once rated by users, would yield an output of Lean readiness levels along with a description of processes which guide managers to address gaps in preparation for Lean. Further research on the tool's prediction exactitude, and the effectiveness of the CSFs for the introduction of Lean in South African public hospitals, would be beneficial to the Lean body of knowledge.

9.4. Conclusions (in terms of Objective 4): Developing a Lean Success Predictor for Rapid Initiation Tool (Lean SPRInT) using Identified CSFs

Lean SPRInT uses sets of elements of three CSFs for Lean implementation which have been identified through an intricate research process involving factor analysis and SEM. Lean SPRInT provides a very basic and user-friendly interface for data input and yields an output of ranked readiness levels and processes which guides managers in addressing gaps and initiating Lean.

It is important to note that, although the level of success prediction is fairly accurate from a theoretical perspective, several factors play a role in the deployment of Lean (Mostafa *et al.*, 2013). The possible failures in Lean initiation processes are often associated with poor mindset and inadequate understanding of the Lean concept itself, as opposed to the quality of the initiation tools (Mostafa *et al.*, 2013).

To enhance the versatility of Lean SPRInT, it is advisable that a phasic approach for Lean initiation be followed. The tool could be integrated into a sequential Lean implementation framework to facilitate appropriate resource deployment as the Lean journey progresses. The Healthcare Lean Assessment (HLA) instrument is recommended as a suitable ongoing implementation assessment tool, providing control measures and corrective actions as the roll-out proceeds (Machado Guimarães and Crespo de Carvalho, 2014). The researcher and developer of Lean SPRInT endeavours to further enhance and evaluate the functionality and application of the tool as funding becomes available.

9.5 Recommendations

9.5.1 Introduction

The fundamental value of the research findings ultimately lies in the Lean SPRInT which is a useful conduit for guiding managers with the assignment of resources, focusing on priority deficiencies within the organisation for the successful initiation of Lean. However, it is essential to provide practical recommendations in line with each of the key objectives of the research.

9.5.2 Recommendations in terms of Objective 1 (baseline knowledge and experience of Lean amongst managers)

Unearthing the baseline knowledge and experience of Lean amongst public health-care managers in KwaZulu-Natal guides relevant stakeholders on the crucial elements and the target audience on which to focus in the development and implementation of Lean training programmes. It is recommended that the KwaZulu-Natal Department of Health capitalise on a cadre of enthusiastic managers with more than 10 years of experience in the health sector for Lean implementation. These senior managers had some pre-existing knowledge of and interest in Lean. Focus should be placed on enhancing the use of Lean tools and techniques, such as PDCA, 5-Why, 5-S and A3 chart, as part of Lean implementation in public hospitals. Other tools and techniques, such as andons and *kanbans*, should be taught through formal Lean training programmes.

As has been found, the current approach to Lean in terms of Petterson's model in KwaZulu-Natal public hospitals lies within the 'Toolbox Lean' quadrant (Pettersen, 2009). This classification suggests that these hospitals would benefit from a knowledge of critical success factors for Lean initiation to raise the degree of Lean industriousness to 'Lean thinking' in Petterson's model.

Managers also strongly felt that there was an opportunity for adopting Lean practices and applying tools and techniques which could possibly improve the operational performance of their hospitals. Considering this interest in Lean application, the senior managers working in all public hospitals in KZN would be ideally placed for training on Lean and involvement in the implementation of Lean.

9.5.3 Recommendations in terms of Objective 2 and Objective 3 (identified variables and CSFs for Lean initiation)

The three CSFs must not be viewed in isolation, as they each have significant implications at different capability dimensions within an organisation (Andersen *et al.*, 2014). The application of the CSFs and the content, context, use, and results of Lean should be viewed considering the organisation's technical, strategic, cultural and structural environment (Andersen *et al.*, 2014). Lean interventions "must be adapted to local conditions, with a focus on value creation for the patient, the culture of the workforce, substantial localised training on Lean tools and techniques, and accurate and robust data" (Andersen *et al.*, 2014).

Health-care managers are advised to provide a supportive environment with effective communication and regular feedback to clients and employees. Furthermore, espousing a holistic quality improvement philosophy with the development and implementation of a long-term continuous improvement plan in a cross-functional and multidimensional approach is recommended.

Although each CSF consists of a list of elements which provide a useful guideline for managers to evaluate their organisation's state of readiness for Lean implementation, the use of the Lean SPRInT is advised.

9.5.4 Recommendations in terms of Objective 4 (the genesis of the Lean SPRInT)

It is advisable that a phasic approach to Lean initiation be followed when utilising the Lean SPRInT. The tool could be integrated in a sequential Lean implementation framework to facilitate appropriate resource deployment as the Lean journey progresses. A benefit of using a sequenced approach is an integration of the monitoring and evaluation process to ensure that results within each phase of implementation are delivered according to the organisational expectations (Mostafa *et al.*, 2013). Milestones would mark the end of each phase of the roll-out, such that a go or no-go decision can be made before entering the next phase.

Having a Lean office in the organisation, or a designated monitoring and evaluation official to monitor the progress made is recommended. Additional infrastructure or other resources are not essential for such an office, as existing quality managers and/or monitoring and evaluation (M&E) managers can be utilised for this purpose. Alternatively, dependent on the size of the institutions wanting to implement Lean, zonal or district-level quality managers or M&E managers could be designated for Lean simultaneous facilitation in multiple facilities under their control. This centralised top-down facilitation of Lean would augment the teamwork required to implement Lean on a large scale, and espouse the rationale of CSF 1 (Strategic leadership and organisational attitude).

For the purpose of monitoring and assessing the roll-out of Lean, the healthcare lean assessment (HLA) instrument is recommended as a suitable tool, providing control measures and corrective actions as the roll-out proceeds (Machado Guimarães and Crespo de Carvalho, 2014). The HLA instrument prevents returning to the comfort zone, and guides the Lean journey. The instrument can be used as an "as is" diagnostic tool, assessing whether each process should be improved, disrupted, or eliminated; also as an instrument for continuous assessment for implementation, providing control measures and corrective actions (Machado Guimarães and Crespo de Carvalho, 2014).

9.5.5 Recommendations in terms of wide-scale Lean SPRInT deployment

The researcher has described a six-step process or road map for the deployment of Lean SPRInT in public hospitals. Top management buy-in precedes the establishment of Lean promotion offices and/or facilitators using existing resources such as quality and M&E managers as shared resources within health districts. Empowerment of these officials through training is essential.

One of the steps in the Lean road map involves conducting Lean SPRInT assessments of hospitals. Such must be carried out by senior managers of the hospital and facilitated by quality and M&E managers, either wholly within their facilities, or jointly with multiple facilities if a district-level quality of M&E managers is used to facilitate Lean roll-out. Following the Lean SPRInT assessment, identified gaps must be addressed through a structured approach. Lean SPRInT assessments and addressing shortfalls are repeated in an iterative process until the tool predicts a global readiness level of 1, heralding the readiness to proceed with Lean initiation. As recommended above, a phasic approach for Lean implementation, together with close monitoring to prevent slippage using the HLA instrument, is recommended.

It is suggested that unified efforts of clinical and non-clinical services in health-care facilities, decentralised clinical and managerial decision-making and culture transformation are more likely to lead to better outcomes of Lean initiation (Doherty, 2013). Such an approach is likely to sustainably improve operational efficiency, and narrow the strategic intervention-implementation gap for successfully achieving targeted health outcomes.

9.6 Areas for Further Research

This study reports on the baseline knowledge, experience and perceptions of Lean amongst managers, thus providing a useful starting point for the implementation of training health-care managers in KZN public hospitals on Lean. After training, the knowledge, experience and perceptions of Lean should be assessed again and compared with the baseline results. This will allow health-care managers to assess the utility and impact of Lean training.

Although the study addresses all the research questions and objectives, it does not consider the aftermath (the evaluation of Lean SPRInT once put into practice). Future research to appraise the effectiveness and practicality of Lean SPRInT is recommended. Once the Lean SPRInT is applied in hospitals, it would be useful to conduct a quasi-experimental or before-and-after study and/or other observational studies to assess, *inter alia*:

- Managers' awareness of the gaps identified during the Lean SPRInT assessments in their hospitals before and after the application of Lean SPRInT;
- Managers' perceptions and knowledge of the Lean readiness or success factors in their hospitals before and after the use of Lean SPRInT;
- The outcomes that Lean SPRInT produces in relation to the initiation of Lean in their hospitals;
- The utility of Lean SPRInT in terms of user-friendliness and suitability;
- The challenges experienced by managers with the use of Lean SPRInT; and
- The degree to which Lean SPRInT accurately predicts success of Lean initiation by comparison of its implementation and outcomes across several hospitals.

Research on the utilization or uptake of Lean SPRInT in public hospitals, and correlation of the findings with the successful initiation of Lean will be useful in determining the value of the tool. A survey on the attitudes and perceptions of senior managers with regard to Lean SPRInT will provide useful information for the developer to consider in refining the tool.

Users' ongoing feedback to the developer of the tool would allow for further enhancements and upgrades. Adaptation of the Lean SPRInT for Community Health Centres and Primary Health Care Clinics, and even for manufacturing or other service industries would be possible if a similar conceptual framework could be used to identify CSFs relevant to those sites and industries and to provide useful data for the modification of the tool**.**

9.7 Summary

This seminal study described the baseline level of knowledge, experience and perceptions of Lean amongst senior health-care managers in public hospitals in KZN and analysed the variables responsible for successful initiation of Lean. The research employed the use of factor analysis and structural equation modelling which led to the identification of scientifically valid CSFs which reliably predict the successful initiation of Lean in KZN public hospitals. These CSFs are: (1) Strategic leadership and organisational attitude, (2) Integration of Lean elements, tools and techniques and (3) Basic stability in operational processes.

A unique and pioneering electronic tool, the Lean SPRInT, was then developed from the results of the factor analysis and structural equation modelling. This user-friendly and reliable electronic tool provides managers with a means of analysing the baseline Lean readiness status of their hospitals in terms of the CSFs, providing guidance for initiating Lean in their hospitals.

The study consisted of five articles (represented in Chapters 4 to 8) as summarised below:

The first article is entitled "*An Overview of Critical Success Factors for Lean Implementation in Health Care*". This article serves to provide a cursory overview of key literature available on CSFs for Lean, both within and external to the health-care sector.

The second article is entitled "*Knowledge and Experience of Lean amongst Senior Health Care Managers in Selected Public Hospitals in KwaZulu-Natal, South Africa*". The article corresponds to Objective 1 and provides the results of an investigation into the baseline level of knowledge and experience of Lean amongst senior health-care managers in public hospitals in KwaZulu-Natal.

The third article is entitled "*Critical Success Factors for the Successful Initiation of Lean in Public Hospitals in KwaZulu-Natal: A Factor Analysis and Structural Equation Modelling Study*". This article corresponds to Objective 2 and Objective 3 of the study which are to identify the key variables for the successful initiation of Lean in public hospitals; and to conduct factor analysis and SEM leading to the identification of CSFs for Lean initiation. The identified CSFs are then explored further in relation to existing literature.

The fourth article is entitled "*The Genesis of the Lean Success Predictor for Rapid Initiation Tool (Lean SPRInT): A Tool for Initiating Lean in South African Public Hospitals*" and corresponds to Objective 4 of the study. The results of EFA, CFA and SEM which were used to identify the CSFs, each of which consists of elements which itemise the factor, are employed in the genesis of Lean SPRInT. This article explores the development and architecture of Lean SPRInT.

The fifth article, "*Lean SPRInT: A management tool for initiating Lean in public hospitals in KwaZulu Natal*" corresponds to the conclusion and recommendations of the study. It proposes a trajectory for the large-scale deployment of the Lean SPRInT in the KwaZulu-Natal Department of Health with the aim of implementing Lean in health facilities. A 6-step Lean road map incorporating the Lean SPRInT, is described, along with a framework for phasic Lean implementation and the Shingo transformation model for sustainability.

9.8 Overall Conclusion and Unique Contribution of the Study

The aim of the research was achieved by the development of a Lean success predictor tool (Lean SPRInT) for the initiation of Lean in public hospitals across KZN, South Africa. This thesis expounded on the process of identifying the CSFs for the initiation of Lean and the development of a Lean readiness assessment tool which predicts the success of Lean initiation in KZN public hospitals.

The baseline knowledge, experience, and perceptions of Lean thinking amongst senior health-care managers in KZN public hospitals was established. Although the level of knowledge and experience with Lean and its tools and techniques was found to be very low amongst the managers, they strongly felt that there was an opportunity for adopting Lean practices which could possibly improve the operational performance of their hospitals.

Three CSFs for the initiation of Lean in KZN public hospitals were identified: (1) Strategic leadership and organisational attitude; (2) Integration of Lean elements, tools and techniques; and (3) Basic stability in operational processes. These CSFs formed the mainstay of the development of the Lean SPRInT which is proposed as a launch tool enabling health-care managers to predict the success or failure of Lean, given their respective hospital's existing resources, processes, and skillset inheritance.

Ultimately, on the strength of achieving all four research objectives, this important study contributes substantially to the Lean body of knowledge, and augurs well for the initiation of Lean in KZN public hospitals.

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ANNEXURES

Annexure A: Information Sheet and Informed consent

PREDICTORS FOR THE SUCCESSFUL INITIATION OF LEAN IN SOUTH AFRICAN PUBLIC HOSPITALS: THE GENESIS OF THE 'LEAN SPRInT' Research Information Sheet and Consent Form

Dear Sir/Madam

My name is Dr. L. Naidoo and I work at Grey's Hospital, Pietermaritzburg as a Senior Manager – Medical Services. I am a part-time PhD (Management) student at UKZN. My contact details are: 0835504811 or 0338973317 or 0836078108 or benzzn@webmail.co.za

You are being invited to consider participating in a study that involves research on identifying critical success factors for Lean initiation. Lean thinking (or "Lean") is a philosophy involving proven operations practices and techniques to improve the quality and efficiency of production and service delivery by eliminating non-value-adding processes ("waste") and improving flow. Lean, derived from the Toyota Production System in Japan, has proven to be of immense benefit in improving operational efficiency in areas such as waiting times, medication errors and hospital acquired infections.

By determining the baseline level of knowledge of Lean amongst public health care managers in KwaZulu-Natal, the researcher would then be able to determine the critical success factors for the initiation of Lean in public hospitals across KwaZulu-Natal. In doing so, the researcher will be in a position to develop a practical Lean success predictor tool (Lean Success Predictor for Rapid Initiation Tool or Lean SPRInT) by employing the factors. This tool can then be adopted for predicting the success or failure of Lean initiation for the swift roll out thereof in public hospitals in KwaZulu-Natal.

The aim of the research is to develop a Lean initiation success predictor tool (Lean SPRInT) for the rapid initiation of Lean in public hospitals across KwaZulu-Natal, South Africa. The study is expected to include 500 senior and executive managers from 73 public hospitals in KwaZulu-Natal. It will involve the following procedures: You will only be asked to complete one questionnaire and to return this electronically to the researcher. The information that you provide in the questionnaire will not negatively affect you and will be treated with strict confidentiality. Your name will not be required, and any other information that could identify you will never be used in any report, publication, or presentation. The duration of your participation, if you choose to participate, is expected to be 10-15 minutes only. The study, which includes the data collection and analysis, will take about 6-12 months.

The study may involve the following risks and/or discomforts: 10-15 minutes of your time to complete the questionnaire and return to the research. To protect your privacy, you will not be asked for your name in the questionnaires. The information that you provide in the questionnaires will not negatively affect you and will be treated with strict confidentiality. Any information that could identify you will never be used in any report, publication, or presentation. We hope that the study will create the following benefits: Lean SPRInT would contain the critical success factors which predict success of failure for rapid Lean initiation in public hospitals. Managers like yourself would be able to use the tool to predict the success or failure of Lean, given your existing resources, processes and skillset inheritance.

This study has been ethically reviewed and approved by the UKZN Humanities and Social Sciences Research Ethics Committee (***approval number HSS/0031/016D***).

In the event of any problems or concerns/questions you may contact the researcher at 0835504811 or 0338973317 or 0836078108 or benzzn@webmail.co.za or the UKZN Humanities & Social Sciences Research Ethics Administration, contact details as follows:

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION
Research Office, Westville Campus
Govan Mbeki Building
Private Bag X54001
Durban, 4000, KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2604557- Fax: 27 31 2604609
Email: HSSREC@ukzn.ac.za

Your participation in the study is voluntary and by participating, you are granting the researcher permission to use your responses. You may refuse to participate or withdraw from the study at any time with no negative consequence. There will be no monetary gain from participating in the study. Your anonymity will be maintained by the researcher and the School of Management, I.T. & Governance and your responses will not be used for any purposes outside of this study.

All data, both electronic and hard copy, will be securely stored during the study and archived for 5 years. After this time, all data will be destroyed.

If you have any questions or concerns about participating in the study, please contact me or my research supervisor at the numbers listed above.

Sincerely,

Dr. L. Naidoo

Consent Form

I have been informed about the study entitled "*Predictors for the Successful Initiation of Lean in South African Public Hospitals: The Genesis of the 'Lean SPRInT'*" by Dr. L. Naidoo.

I understand the purpose and procedures of the study. I have been given an opportunity to answer questions about the study and have had answers to my satisfaction.

I declare that my participation in this study is entirely voluntary and that I may withdraw at any time without incurring any penalty.

I have been informed that there is no cost implication of remuneration/income for participation.

If I have any further concerns or queries related to the study, I understand that I may contact the researcher on 0835504811 or 0338973317 or 0836078108 or benzzn@webmail.co.za

If I have any questions or concerns about my rights as a study participant, or if I am concerned about an aspect of the study or the researcher, then I may contact:

If I have any questions or concerns about my rights as a study participant, or if I am concerned about an aspect of the study or the researchers then I may contact:

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION
Research Office, Westville Campus
Govan Mbeki Building
Private Bag X 54001
Durban 4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2604557 - Fax: 27 31 2604609
Email: HSSREC@ukzn.ac.za

______________________ ______________________ ______________

Name of Participant **Signature of Participant** **Date**

Annexure B: Research Questionnaire

SECTION A: GENERAL INFORMATION

[A1] Which one of the following best describes the classification of the hospital in which you work? Please tick one option.

- District level ☐
- Regional level ☐
- Tertiary/ Central ☐
- TB ☐
- Psychiatry ☐
- Combo district/ regional ☐
- Combo regional/tertiary ☐
- Combo district/regional/tertiary ☐
- Step-down facility ☐
- Other (Specify below) ☐

____

[A2] Within which district does your hospital fall? Please tick one option.

- Amajuba ☐
- uMgungundlovu ☐
- uThungulu ☐
- eThekwini ☐
- Umkhanyakude ☐
- Zululand ☐
- Uthukela ☐
- Ilembe ☐
- Umzinyathi ☐
- Ugu ☐
- Sisonke ☐

[A3] Which one of the following best describes your occupational category (even if you are acting or serving relief in the position)? Please tick one option.

- Hospital manager/ CEO ☐
- Nursing Manager ☐
- Medical Manager ☐
- Finance Manager ☐
- Systems Manager ☐
- Human Resource Manager ☐
- Maintenance/ Engineering Manager ☐
- Quality Manager ☐
- M&E Manager ☐

[A4] Please indicate the number of months/ years of middle to senior management experience you have in the health sector. Please tick one option.

- Less than 6 months ☐
- ≥6 months but <1 year ☐
- ≥1 year but <2 years ☐
- ≥2 years but <5 years ☐
- ≥5 years but <10 years ☐
- ≥10 years ☐

SECTION B: KNOWLEDGE OF AND EXPERIENCE WITH LEAN

[B1] Prior to reading this information sheet, consent form and questionnaire, have you ever heard or read about Lean thinking or Lean manufacturing (also referred to as Lean)?

Yes ☐ No ☐

If your answer to [B1] is "No", please skip to question [B2].

[B1.1] If your answer to [B1] is "Yes", where did you hear or read about Lean? You may select more than one option.

- Colleagues/ Friend/ Informal setting ☐
- Training course/ workshop/ conference held outside the KZN Department of Health ☐
- Training course/ workshop/conference held within the KZN Department of Health ☐
- While studying towards a formal qualification (degree/ diploma/ certificate) ☐
- Newspaper, TV, pamphlet, brochure ☐
- Internet search, non-academic website ☐
- Academic journal, text book, research work ☐
- Other (specify) ____ ☐

[B1.2] If your answer to [B1] if "Yes", how would you rate your level of knowledge on Lean, in the box below, on a scale from 1 to 5 ('1' being "extremely poor" and '5' being "expert")?

☐

[B1.3) Have you come across or do you know of any of the tools and techniques of Lean?

Yes ☐ No ☐

[B1.3.1] If your answer to [B1.3] is "Yes" which tool(s) have you come across or are you aware of?

____

____

[B1.4] Have you used or applied any of the tools and techniques of Lean previously?

Yes ☐ No ☐

[B1.4.1] If your answer to [B1.4] is "Yes" tick which tool(s) have you applied or used previously and indicate your level of experience/skill with the application by ticking the relevant column?

Tool/ technique	**Applied / used previously?**		**Level of experience/ skill**		
	Yes	*No*	*Basic/ Novice*	*Mediocre*	*Expert*
1.4.1 Valued stream maps					
1.4.2 A3 chart					
1.4.3 5-why					
1.4.4 5-S					
1.4.5 PDCA (Plan, Do, Check, Act)					
1.4.6 Andons/ kanbans					
1.4.7 Poka yokes					
1.4.8 Jidoka					
1.4.9 JIT					
1.4.10 Other (specify)					

[B1.5] Please indicate the number of months/years of practical experience/ involvement you have with Lean thinking in your career lifetime. Please tick one option.

Nil ☐
≥6 months but <1 year ☐
≥2 years but <5 years ☐
Less than 6 months ☐
≥1 year but <2 years ☐
≥5 years ☐

[B1.6] Please indicate the number of months/years of practical experience/ involvement you have with Lean thinking in the HEALTH sector. Please tick one option.

Nil ☐
≥6 months but <1 year ☐
≥2 years but <5 years ☐
Less than 6 months ☐
≥1 year but <2 years ☐
≥5 years ☐

[B2] From reading the attached information sheet about Lean, would you be interested in learning more about Lean thinking?

Yes ☐ No ☐

[B3] From reading the attached information sheet about Lean, do you think there is an opportunity for adopting Lean practices and applying tools and techniques in your hospital? In the box below, indicate your rating on a scale from 1 to 5 ('1' being "Most definitely" and '5' being "Definitely not")?

☐

[B4] From reading the attached information sheet about Lean, do you think that Lean practices could possibly improve the operational/systems performance in your hospital? In the box below, indicate your rating on a scale from 1 to 5 ('1' being "Most definitely" and '5' being "Definitely not")?

☐

SECTION C: KEY VARIABLES FOR SUCCESSFUL LEAN IMPLEMENTATION

Listed below are some of the variables that could influence and eventually determine the successful implementation of Lean as a hospital management strategy.

Using the following scale please indicate to what extent you agree or disagree with statements by circling the appropriate number in each row: 1 = strongly disagree; 2 = disagree; 3 = somewhat/slightly disagree; 4 = somewhat/slightly agree; 5 = agree; 6 = strongly agree.

Code	Variable	Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strong agree
A2	An organisation implementing Lean must face and embrace the various attitudinal aspects of Lean.	1	2	3	4	5	6
L1	Leadership at all levels in the organisation must drive, live and demonstrate Lean behavior.	1	2	3	4	5	6
E2	Lean people make Lean organisation, and as such the people have to get Lean before the organisation can get Lean.	1	2	3	4	5	6
A1	The mindset and attitude or behavior of people is fundamental to Lean success.	1	2	3	4	5	6
E4	Ultimately it is the knowledge, skills, involvement and commitment of ordinary people that will make the difference to Lean success.	1	2	3	4	5	6
S1	Lean philosophy and principles must be reflected in the organization's business strategy.	1	2	3	4	5	6
E1	The goals of Lean can only be achieved through the efforts of its people	1	2	3	4	5	6
S2	There must be a clear link between the organisation goals, key objectives and Lean activities.	1	2	3	4	5	6
A3	For Lean to be successfully implemented, all levels of employees must buy into Lean.	1	2	3	4	5	6
L2	Lean leadership creates/leads to Lean thinking.	1	2	3	4	5	6
S3	Lean implementation must be driven as a high priority strategic business initiative.	1	2	3	4	5	6
B1	At the beginning of Lean transformation the organisation needs lots of basic stability before it can proceed with the more sophisticated elements of Lean.	1	2	3	4	5	6
L4	The difference between Lean success and failure starts with leadership.	1	2	3	4	5	6
B4	Stability in operating systems is a pre-requisite for Lean transformation.	1	2	3	4	5	6
A4	Employees' cognitive dimensions or perceptions of Lean are key to successful Lean implementation.	1	2	3	4	5	6
S4	Lean should be implemented as a business strategy and not a tactic/method.	1	2	3	4	5	6
F1	An organisation embarking on a Lean journey will need the support and guidance of a Lean facilitator(s) with substantial experience with Lean implementation.	1	2	3	4	5	6

Code	Variable	Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strong agree
E3	The essence of Lean is people working within the Lean philosophy and principles.	1	2	3	4	5	6
B2	General predictability and consistent availability in terms of manpower, machines, materials and methods is a pre-condition for Lean implementation.	1	2	3	4	5	6
F4	A dedicated project leader of facilitator will have a positive impact on Lean implementation.	1	2	3	4	5	6
T2	The selection and application of the appropriate Lean tools are critical for successful Lean implementation.	1	2	3	4	5	6
I2	All business systems, programmes and structures must be aligned with the Lean philosophy, principles, practices and methods.	1	2	3	4	5	6
F2	An internal Lean systems builder is needed to sustain Lean after an external expert has initiated Lean and left.	1	2	3	4	5	6
I3	The effectiveness of the Lean operating system comes from the integrate nature of its practices and methods.	1	2	3	4	5	6
T3	It is important to understand the organisation's processes and only apply the Lean tools and techniques applicable to that specific process type.	1	2	3	4	5	6
F3	A Lean promotion office where facilitators/ promoters of Lean can be located must be established in the organisation.	1	2	3	4	5	6
I1	The organisation must integrate the soft issues of Lean (such as culture, mindset and behaviour) with the hard issues (such as tools, systems, structure and processes)	1	2	3	4	5	6
T4	The application of Lean tools and techniques by itself will ensure Lean success.	1	2	3	4	5	6
B3	Work must be standardized before embarking on a Lean journey.	1	2	3	4	5	6
T1	Key to sustainable Lean performance is having the right Lean tools and techniques in place	1	2	3	4	5	6
I4	The organisation must use all of the goals, methods, techniques and foundation elements of Lean in combination.	1	2	3	4	5	6
L3	Knowledgeable and committed executive leadership is the absolute *sin qua non* (essential factor) for Lean success.	1	2	3	4	5	6

Thank you for your time and effort in completing this questionnaire. You participation is highly appreciated.

Please return the signed informed consent form and completed questionnaire via email to Dr. L. Naidoo at benzzn@webmail.co.za

You may contact Dr. L. Naidoo on 0835504811 or 0338973317 or 0836078108 to make alternative arrangements for returning the questionnaire if you do not have email facilities.

Annexure C: KZN Department of Health Letter of Permission

health
Department:
Health
PROVINCE OF KWAZULU-NATAL

DIRECTORATE:

330 Langalibalele street,
Private Bag X9051 PMB, 3200
Tel: 033 395 2805/3189/3123 Fax: 033 394 3782
Email: hrkm@kznhealth.gov.za
www.kznhealth.gov.za

Health Research & Knowledge Management (HKRM)

Reference: **HRKM22/16**
KZ_2016RP31_475

08 February 2016

Dear Dr L Naidoo
(University of KwaZulu-Natal)

Subject: Approval of a Research Proposal

1. The research proposal titled **'PREDICTORS FOR THE SUCCESSFUL INITIATION OF LEAN IN SOUTH AFRICAN PUBLIC HOSPITALS: THE GENESIS OF THE 'LEAN SPRInT'** was reviewed by the KwaZulu-Natal Department of Health (KZN-DoH).

   The proposal is hereby **approved** for research to be undertaken at all selected facilities at KZN-DoH.

2. You are requested to take note of the following:
   a. Obtain support letters from the health districts and make necessary arrangement with the identified facilities **before** commencing with your research project.
   b. Provide an interim progress report and final report (electronic and hard copies) when your research is complete.

3. Your final report must be posted to **HEALTH RESEARCH AND KNOWLEDGE MANAGEMENT, 10-102, PRIVATE BAG X9051, PIETERMARITZBURG, 3200** and e-mail an electronic copy to hrkm@kznhealth.gov.za

For any additional information please contact Ms G Khumalo on 033-395 3189.

Yours Sincerely

Exlutge

Dr E Lutge
Chairperson, Health Research Committee
Date: 12/02/16

Fighting Disease, Fighting Poverty, Giving Hope

Annexure D: Letter of Permission from KZN Department of Health Deputy Director General: Specialised Services and Clinical Support

health
Department:
Health
PROVINCE OF KWAZULU-NATAL

DIRECTORATE:

121 Chief Albert Luthuli Street, Pietermaritzburg 3200
Private Bag X9051, Pietermaritzburg, 3200
Tel: 033 846 7209 Fax: 033 846 7235 Email: Lindiwe.simelane@kznhealth.gov.za
www.kznhealth.gov.za

Specilaised Services and Clinical Support

Reference: 114/15

17 December 2015

Dr Ziska Fields
University of KwaZulu Natal
University Road, Westville Campus

PERMISSION TO CONDUCT RESEARCH AS PART OF THE PHD QUALIFICATION

Reference is made to the attached letter dated 13 December 2015 with regards to the above mentioned subject.

Kindly be advised that permission is granted to **Dr Logandran Naidoo (Student No. 993212931)** to conduct the Research Project entitled: *Predictors for the Successful Initiation of Lean in South African Public Hospitals: The Genesis of the "Lean SPRInT"*

Please find attached herewith the completed Gatekeepers Consent Form.

Thank you.

DR MLB SIMELANE
DEPUTY DIRECTOR GENERAL: SPECIALISED SERVICES AND CLINICAL SUPPORT
KZN DEPARTMENT OF HEALTH

Fighting Disease, Fighting Poverty, Giving Hope

Gatekeeper's Consent

I SIMELANE MLB in my capacity as DDG: ....hereby give permission to **Dr. Logandran Naidoo (Student No. 993219231)** to conduct research in my organization.

The student ~~MAY~~/MAY NOT (delete whichever is not applicable) use the name of the organisation in the dissertation.

Signature of Manager / Gatekeeper: ....

Company/Organisation Stamp:

SENIOR GENERAL MANAGER
SPECIALISED SERVICES & CLINICAL SUPPORT
DR MLB SIMELANE
2015 -12- 17
DEPARTMENT OF HEALTH
KWAZULU - NATAL

Date: 17 /12 /2015

Annexure E: Final Ethics Approval

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

22 January 2016

Dr Logandran Naidoo (993212931)
School of Management, IT & Governance
Pietermaritzburg Campus

Dear Dr Naidoo,

Protocol reference number: HSS/0031/016D
Project title: Predictors for the Successful Initiation of Lean in South African Public Hospitals: The Genesis of the 'Lean SPRInT'

Full Approval – Expedited Application

With regards to your application received on **23** December 2015. The documents submitted have been accepted by the Humanities & Social Sciences Research Ethics Committee and **FULL APPROVAL** for the protocol has been granted.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number.

Please note: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

....

Dr Shenuka Singh (Chair)

/ms

Cc Supervisor: Dr Ziska Fields
Cc Academic Leader Research: Professor Brian McArthur
Cc School Administrator: Ms Debbie Cunyngham

Humanities & Social Sciences Research Ethics Committee
Dr Shenuka Singh (Chair)
Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Telephone: +27 (0) 31 260 3587/8350/4557 **Facsimile:** +27 (0) 31 260 4609 **Email:** ximbap@ukzn.ac.za / snymanm@ukzn.ac.za / mohunp@ukzn.ac.za
Website: www.ukzn.ac.za

1910 - 2010
100 YEARS OF ACADEMIC EXCELLENCE

Founding Campuses: Edgewood | Howard College | Medical School | Pietermaritzburg | Westville

Annexure F: Ethics approval re-certification

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

09 January 2019

Dr Logandran Naidoo (993212931)
School of Management, IT & Governance
Pietermaritzburg Campus

Dear Dr Naidoo,

Protocol reference number: HSS/0031/016D
Project title: Predictors for the Successful Initiation of Lean in South African Public Hospitals: The Genesis of the 'Lean SPRInT'

Approval Notification – Recertification Application

Your request for Recertification dated 10 December 2018 was received.

This letter confirms that you have been granted Recertification Approval for a period of one year from the date of this letter. This approval is based strictly on the research protocol submitted and approved in 2016.

Any alteration s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study must be reviewed and approved through the amendment /modification prior to its implementation. Please quote the above reference number for all queries relating to this study.

PLEASE NOTE: Research data should be securely stored in the school/department for a period of 5 years

Yours faithfully

....

Professor Shenuka Singh (Chair)

/ms

Cc Supervisor: Professor Ziska Fields
Cc Academic Leader Research: Professor Isabel Martins
Cc School Administrator: Ms Debbie Cunynghame

Humanities & Social Sciences Research Ethics Committee
Dr Shenuka Singh (Chair)
Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Telephone: +27 (0) 31 260 3587/8350/4557 **Facsimile:** +27 (0) 31 260 4609 **Email:** [illegible] / [illegible] / [illegible]
Website: www.ukzn.ac.za

1910 - 2010
100 YEARS OF ACADEMIC EXCELLENCE

Founding Campuses: Edgewood Howard College Medical School Pietermaritzburg Westville

Annexure G: Amended Ethics Approval for Addition of Co-Supervisor

UNIVERSITY OF KWAZULU-NATAL™
INYUVESI YAKWAZULU-NATALI

12 April 2019

Dr Logandran Naidoo (993212931)
School of Management, IT & Governance
Pietermaritzburg Campus

Dear Dr Naidoo,

Protocol reference number: HSS/0031/016D
Project title: Predictors for the Successful Initiation of Lean in South African Public Hospitals: The Genesis of the 'Lean SPRInT'

Approval Notification – Amendment Application

This letter serves to notify you that your application and request for an amendment received on 11 April 2019 has now been approved as follows:

- Addition of Supervisor

Any alterations to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form; Title of the Project, Location of the Study must be reviewed and approved through an amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for period of 3 years from the date of original issue. Thereafter Recertification must be applied for on an annual basis.

Best wishes for the successful completion of your research protocol.

Yours faithfully

....

Dr Rosemary Sibanda (Chair)

/ms

Cc Supervisor: Professor Ziska Fields and Dr Evelyn Derera
Cc Academic Leader Research: Professor Isabel Martins
Cc School Administrator: Ms Debbie Cunynghame

Humanities & Social Sciences Research Ethics Committee
Dr Rosemary Sibanda (Chair)
Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Telephone: +27 (0) 31 260 3587/8350/4557 **Facsimile:** +27 (0) 31 260 4609 **Email:** [illegible] / [illegible] / [illegible]
Website: www.ukzn.ac.za

1910 - 2010
100 YEARS OF ACADEMIC EXCELLENCE

Founding Campuses: Edgewood, Howard College, Medical School, Pietermaritzburg, Westville

Annexure H: Letter of Permission from Gatekeeper for Publication of Results

health

Department:
Health
PROVINCE OF KWAZULU-NATAL

DIRECTORATE:

Natalia building, 330 Langalibalele street
Private bag X9051 PMB 3200
Tel. 033 395 2046Fax: 033 394 3782
Email: Elizabeth.lutge@kznhealth.gov.za
www.kznhealth.gov.za

Epidemiology & Health Research & Knowledge Management (HRKM)

26th October 2018

Dr Logandran Naidoo
Greys Hospital
Pietermaritzburg

RE: PERMISSION TO PUBLISH RESULTS FROM PhD

You are permitted to publish the results from your PhD degree in peer reviewed journals, since you had the relevant approvals for the research (from both the KZN Department of Health and an ethics committee).

Research results should be disseminated in order to ensure that they can be used. Your publication of research results in a peer reviewed journal is part of this dissemination and is supported.

Yours faithfully

Elizabeth Lutge
Director: Epidemiology, Health Research and Knowledge Management Units
KwaZulu-Natal Department of Health

Fighting Disease, Fighting Poverty, Giving Hope

Annexure I: Proof of submission of Article 1 to South African Health Review journal

RE: Abstract submission for SAHR 2020

EM

Emma Mackie <Emma.Mackie@hst.org.za>
To benzzn@gmail.com

Tue 14:42

Received – thank you.

Emma-Louise Mackie
SAHR Project Coordinator
082 932 4889
emma.mackie@hst.org.za
Download the 2018 SAHR here.

From: benzzn@gmail.com [mailto:benzzn@gmail.com]
Sent: 21 October 2019 07:42 PM
To: SAHR
Subject: Abstract submission for SAHR 2020

Dear SAHR

Kindly find attached my abstract submission for the SAHR 2020.

Regards
Dr. L. Naidoo
Email: benzzn@gmail.com
Telephone: +27836078108

Annexure J: Proof of acceptance of Article 2 for publication in SPOUDAI Journal of Economics and Business

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΙΡΑΙΩΣ
ΣΠΟΥΔΑΙ
Τριμηνιαία Επιστημονική Έκδοση

UNIVERSITY OF PIRAEUS
SPOUDAI
Journal of Economics and Business

November 21, 2019

Dear Professor Ziska Fields,
Dear Dr Logandran Naidoo,

We hereby confirm that your article entitled: "Knowledge and experience of Lean Thinking amongst senior health care managers in selected South African public hospitals" (Authors: Dr Logandran Naidoo (primary author) and Prof. Ziska Fields (corresponding and second author) has been accepted and approved for publication. It will be included in Volume 69, Issue 4 (September - December 2019) of *SPOUDAI Journal of Economics and Business*.

Best Regards

Prof. E. Sambracos
Editor-in-Chief
SPOUDAI
Journal of Economics and Business

Annexure K: Proof of publication of Article 3 in Human Resources for Health (Reference number HRHE-D-18-00059R3)

Naidoo and Fields *Human Resources for Health* (2019) 17:69
https://doi.org/10.1186/s12960-019-0405-1

Human Resources for Health

RESEARCH Open Access

Critical success factors for the successful initiation of Lean in public hospitals in KwaZulu-Natal: a factor analysis and structural equation modelling study

Logandran Naidoo[1] and Ziska Fields[2*]

Abstract

Background: Lean thinking is one of several operations-management techniques which have yet to be fully embraced in the South African health care sector. In most health care managers' service delivery mandates, *what* needs to be done might be known, but it is *how* it should be done which might be alien to most managers. In order to recognise the "how", one needs to know the critical success factors for Lean initiation.

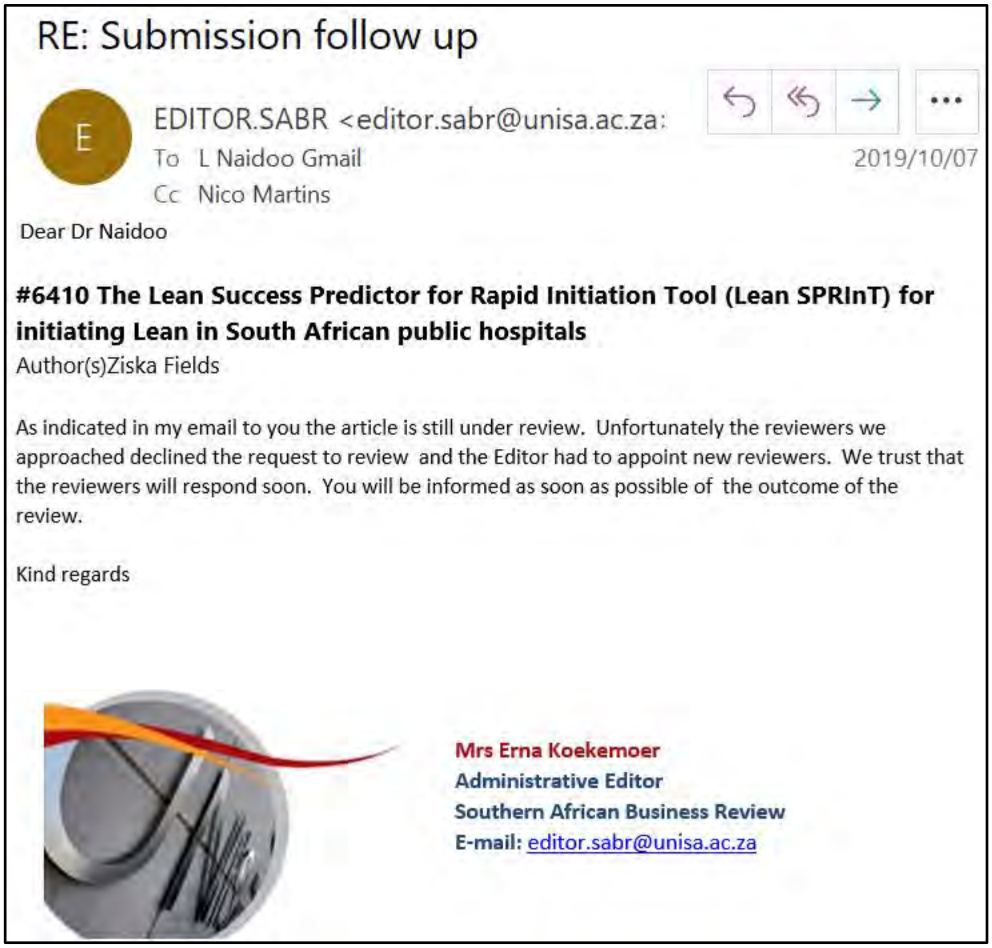
Methods: The research took the form of an observational descriptive study with quantitative methods. The objectives were to identify the key variables for the successful initiation of Lean and then to conduct factor analysis and structural equation modelling (SEM) on these variables leading to the identification of critical success factors (CSFs) for Lean initiation. Simple random sampling was applied to select the participants from various categories of 500 senior managers across 73 KwaZulu-Natal (KZN) public hospitals. The sample size was 218, with a response rate of 96.8% ($n = 211$). For the purpose of identifying key variables for the successful initiation of Lean and then of conducting factor analysis and SEM on these variables, a self-administered, structured questionnaire was used. Data were reduced using exploratory factor analysis (EFA) to identify latent constructs. Confirmatory factor analysis (CFA) was used to determine the reliability and validity of these factors. Structural equation modelling (SEM) fit indices were then applied to assess acceptability of the measurement model.

Results: Certain variables were eliminated during EFA if they cross-loaded onto more than one factor, since this caused discriminant validity problems. In addition, if variables loaded weakly onto a factor, they were not retained. Three critical success factors (CSFs) were identified in this study: strategic leadership and organisational attitude; integration of Lean elements, tools, and techniques; and basic stability in operational processes. All reliability and validity conditions have been met (RMSEA = 0.085; CFI = 0.956 and χ^2/df = 2.513), consequently rendering the model reliable and valid.

Conclusion: None of the three CSFs can be viewed in isolation, as they all have significance at different dimensions of capability within the organisation. The use of these CSFs and the context, content, application, and outcome of Lean should be viewed in light of the organisation's strategic, technical, structural, and cultural environment. Further research in the effectiveness of these CSFs for the rollout of Lean in South African hospitals would be of benefit to the Lean body of knowledge.

* Correspondence: ziskaf@uj.ac.za
[2]University of Johannesburg, Johannesburg, South Africa
Full list of author information is available at the end of the article

Annexure L: Proof of submission of Article 4 to South African Business Review



RE: Submission follow up

EDITOR.SABR <editor.sabr@unisa.ac.za>
To L Naidoo Gmail
Cc Nico Martins
2019/10/07

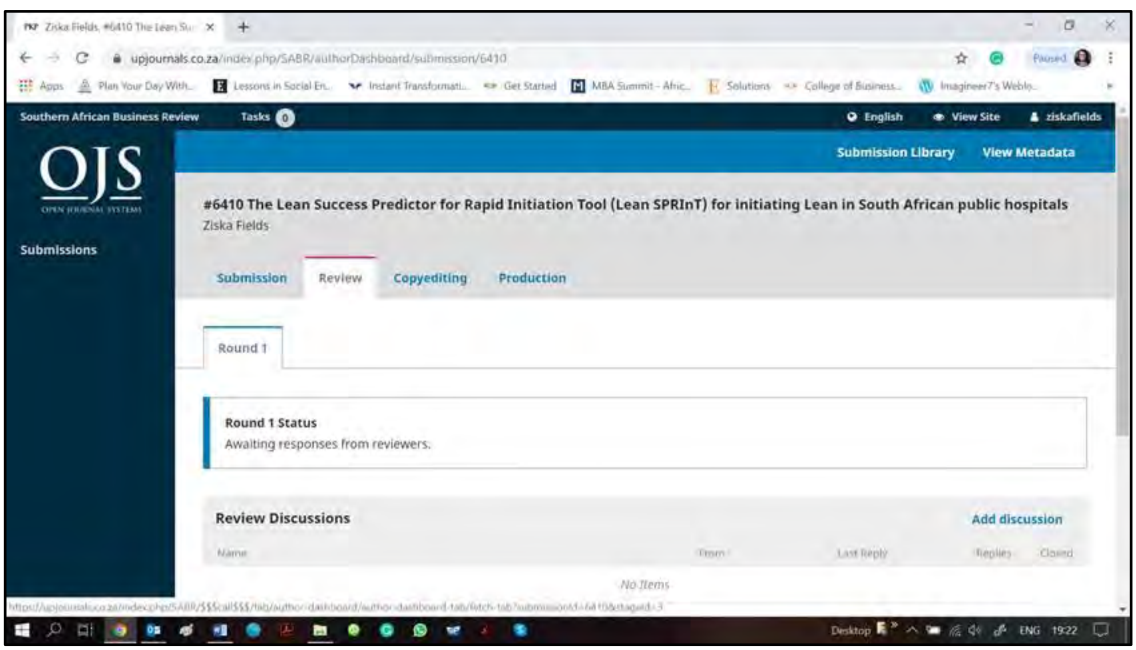
Dear Dr Naidoo

#6410 The Lean Success Predictor for Rapid Initiation Tool (Lean SPRInT) for initiating Lean in South African public hospitals
Author(s)Ziska Fields

As indicated in my email to you the article is still under review. Unfortunately the reviewers we approached declined the request to review and the Editor had to appoint new reviewers. We trust that the reviewers will respond soon. You will be informed as soon as possible of the outcome of the review.

Kind regards

Mrs Erna Koekemoer
Administrative Editor
Southern African Business Review
E-mail: editor.sabr@unisa.ac.za



Annexure M: Proof of publication of Article 5 in Journal of Contemporary Management (JCM 19-030)

31 July 2019

Dear Author/s

Manuscript reference number: JCM 19-030

Manuscript title:
Lean SPRInT: A management tool for initiating Lean in public hospitals in KwaZulu-Natal (Published)

Attachments: copy of published article in PDF. See below the link for SABINET website.

It is a pleasure to inform you that your article was published. Journal of Contemporary Management is delighted to have been a part of the dispersion of your research results.

Kind regards.

Editorial Team
Journal of Contemporary Management

- **Author** L. Naidoo[1] and Z. Fields[2]
- **Affiliations :** 1 University of KwaZulu-Natal and 2 University of Johannesburg
- **Source :** Journal of Contemporary Management, Volume 16 Number 2, 2019, p. 43 - 67
- **Keyword(s) :** Contemporary management tool, Healthcare management, Healthcare system, Lean management and Operational efficiency
- **Accreditation :** Department of Higher Education and Training (DHET)
- **Persistent Link :** https://hdl.handle.net/10520/EJC-173e51e716

Annexure N: Permission from Journal of Contemporary Management to use copyright article in thesis

PERMISSION TO USE COPYRIGHT MATERIAL

1. For inclusion in the examiner's copy of this doctoral thesis and final copy of this doctoral thesis

As copyright holder/licensor/publisher of the following article:

Naidoo, L. & Fields, Z. (2019). Lean SPRInT: A management tool for initiating Lean in public hospitals in KwaZulu Natal. *Journal of Contemporary Management.* 16(2), 43-67.

I grant permission for this article to be included verbatim as a section of **Dr. Logandran Naidoo's (UKZN PhD student – student number 993212931)** doctoral thesis by publications for the purpose of a printed hard- copy being sent to each examiner of the thesis and in the final copy of the thesis.

2. For inclusion in the digital version of this doctoral thesis

As copyright holder/licensor/publisher of the following article:

Naidoo, L. & Fields, Z. (2019). Lean SPRInT: A management tool for initiating Lean in public hospitals in KwaZulu Natal. *Journal of Contemporary Management.* 16(2), 43-67.

I grant permission for this article to be included verbatim as a section of **Dr. Logandran Naidoo's (UKZN PhD student – student number 993212931)** doctoral thesis by publications for the purpose of offering an online version at http://researchspace.ukzn.ac.za or related UKZN research website.

2019/10/31

Prof Ansie Lessing
Managing Editor
Journal of Contemporary Management

Date

Annexure O: Permission from Human Resources for Health to use article in thesis

BioMed Central
4 Crinan Street
London N1 9XW
United Kingdom

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biomedcentral.com

Liz Hoffman
Journal Development Manager
T +44 (0)20 3192 2202
Liz.Hoffman@biomedcentral.com

Logandran Naidoo
University of KwaZulu-Natal,
Pietermaritzburg,
South Africa

7th November 2019

Reuse of your *Human Resources for Health* article

Dear Dr Naidoo,

Thank you for your enquiry regarding the inclusion of the article below, published in *Human Resources for Health*, in your PhD thesis. BMC and SpringerOpen journals apply Creative Commons licences as they are open access.

Title: Critical success factors for the successful initiation of Lean in public hospitals in KwaZulu-Natal: a factor analysis and structural equation modelling study
Authors: Logandran Naidoo and Ziska Fields
Citation: *Human Resources for Health* (2019) **17**:69
Content type: Research
Published on: 23 August 2019
MS ID: HRHE-D-18-00059R3
JWF MS ID: 12960_2019_405

We are delighted to inform you that the authors, of which you are one, are the copyright holders of this article and do not require anyone's permission to reuse this article. The terms of the copyright that apply to this article are shown below, I have bolded the sentence that relates to information that should be included and would suggest that using the PDF that can be downloaded at https://human-resources-health.biomedcentral.com/track/pdf/10.1186/s12960-019-0405-1 is the easiest method of complying with this.

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Kind regards,

Liz Hoffman

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Annexure P: Table of sample sizes based on desired accuracy or confidence levels

Source: (Gill *et al.*, 2010)

`	Variance of the population P=50%					
	Confidence level=95% Margin of error			*Confidence level=99% Margin of error*		
Population Size	5	3	1	5	3	1
50	44	48	50	46	49	50
75	63	70	74	67	72	75
100	79	91	99	87	95	99
150	108	132	148	122	139	149
200	132	168	196	154	180	198
250	151	203	244	181	220	246
300	168	234	291	206	258	295
400	196	291	384	249	328	391
500	217	340	475	285	393	485
600	234	384	565	314	452	579
700	248	423	652	340	507	672
800	260	457	738	362	557	763
1000	278	516	906	398	647	943
1500	306	624	1297	459	825	1375
2000	322	696	1655	497	957	1784
3000	341	787	2286	541	1138	2539
5000	357	879	3288	583	1342	3838
10000	370	964	4899	620	1550	6228
25000	378	1023	6939	643	1709	9944
50000	381	1045	8057	652	1770	12413
100000	383	1056	8762	656	1802	14172
250000	384	1063	9249	659	1821	15489
500000	384	1065	9423	660	1828	15984
1000000	384	1066	9513	660	1831	16244

Annexure Q: Confirmation of proofreading and professional editing of thesis

pinpoint

Proofreading Services

Lydia Weight
NTSD English Specialist
SACE No: 11135129

E-mail: lydiaweight@gmail.com

Pinpoint Proofreading Services

40 Ridge Rd
Kloof
Durban
3610

28 November 2019

To whom it may concern

This is to certify that I, Lydia Weight, have proofread the document titled: Predictors for the successful initiation of Lean in South African public hospitals: The genesis of the Lean SPRInT by Dr Logandran Naidoo. I have made all the necessary corrections. The document is therefore ready for presentation to the destined authority.

Yours faithfully

L.Weight

L. Weight

Annexure R: Turnitin Report

Explanation for Turnitin reports:

In running the **Turnitin Report 1** (Figure R2), no sources were excluded on the Turnitin search parameters. The similarity index is 37% owing to the student's published articles as sources being included on the Turnitin parameters. If these published articles as sources (12%+9%+6%+2%=8%) were subtracted from 37%, the similarity index is 8%. This similarity index is confirmed in Turnitin Report 2. The key sources of the student's published articles reflected on Turnitin are listed in Table R1.

Table R1: Key sources of the student's published articles reflected on Turnitin.

Source reflected on Turnitin	Similarity index	Comments
Student paper "Submitted to Cape Peninsula of Technology (CPUT)"	12%	Corresponds to Article 5 which was published in the Journal of Contemporary Management. Article 5 was submitted on Turnitin by the peer reviewer of the Journal of Contemporary Management via the CPUT Turnitin server. Refer to confirmation by JCM Editor in Figure R1.
"Logandran Naidoo, Ziska Fields. Critical success factors… Human Resources for Health, 2019"	9%	Corresponds to Article 3 which was published in Human Resources for Health.
"www.ncbi.nlm.nih.gov"	6%	Corresponds to Article 3 which was published in Human Resources for Health.
"www.observatoriorh.org"	2%	Corresponds to Article 3 which was published in Human Resources for Health.

In running **Turnitin Report 2** (Figure R3), the above key sources of the student's published articles were excluded on the Turnitin search parameters, giving a similarity index of 8%. This corroborates the similarity index in Turnitin Report 1 once the key source scores are manually subtracted.

JOURNAL OF CONTEMPORARY MANAGEMENT

Est. 2004 ISSN: 1815-7440

email: info.jcman@gmail.com
website: https://journals.co.za/content/journal/jcman

20 November 2019

To whom it may concern

This letter serves to confirm the following with regards to:

Lean SPRInT: A management tool for initiating Lean in public hospitals in KwaZulu-Natal" by Logandran Naidoo and Ziska Fields, which was published in Volume 16 (Issue 2) of Journal of Contemporary Management in July 2019 with Reference JCM19-030.

The source "Student Paper submitted to Cape Peninsula University of Technology" appearing on the Turnitin report of Logandran Naidoo's PhD Thesis reflects the following journal article that was submitted to the Turnitin repository by one of the reviewers' of the article during the peer review process prior to its publication in JCMan.

After consultation with someone working with Turnitin reports. The following was brought to our attention with regards to running the similarity report for the thesis:

1. The Bibliography must be switched off.
2. Due to the fact that the article was already checked by the reviewer, it is stored within the system. Which means it will keep on showing, even if deleted.

   The following switch needs to be disabled: **The Turnitin internal repository**.

Due to the fact that the article went through Turnitin it will always appear as part of any report unless you disable the internal repository.

Thank you.

Prof Ansie Lessing
Managing Editor
Journal of Contemporary Management

Figure R1: Confirmation by Managing Editor of JCM of CPUT source appearing in Turnitin repository being the student's Article 5.

PhD Thesis - 27 Nov 2019

ORIGINALITY REPORT

37%	21%	20%	25%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Cape Peninsula University of Technology Student Paper	12%
2	Logandran Naidoo, Ziska Fields. "Critical success factors for the successful initiation of Lean in public hospitals in KwaZulu-Natal: a factor analysis and structural equation modelling study", Human Resources for Health, 2019 Publication	9%
3	www.ncbi.nlm.nih.gov Internet Source	6%
4	www.observatoriorh.org Internet Source	2%
5	Submitted to University of KwaZulu-Natal Student Paper	1%
6	journals.co.za Internet Source	1%
7	researchspace.ukzn.ac.za Internet Source	<1%

Figure R2: Turnitin Report 1 (Student's published articles as sources included on the Turnitin parameters).

PhD Thesis - 27 Nov 2019

ORIGINALITY REPORT

8%	4%	3%	7%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to University of KwaZulu-Natal Student Paper	1%
2	ujdigispace.uj.ac.za Internet Source	<1%
3	dspace.lib.cranfield.ac.uk Internet Source	<1%
4	Submitted to University of Pretoria Student Paper	<1%
5	Submitted to University of Stellenbosch, South Africa Student Paper	<1%
6	wrap.warwick.ac.uk Internet Source	<1%
7	Submitted to Asia Pacific University College of Technology and Innovation (UCTI) Student Paper	<1%
8	Submitted to University of Warwick Student Paper	<1%

Figure R3: Turnitin Report 2 (Student's published articles as sources excluded on the Turnitin parameters)