An enterprise technology readiness model for artificial intelligence

By

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Declaration

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Abstract

In the continuously changing and developing landscape of business, rapid growth in technology forms a vital part in leveraging competitive advantage and generating new types of value. One of these emerging technologies is artificial intelligence. Businesses wishing to capitalize on the opportunities that this technology could provide, have unique challenges. One of these challenges is the strategic and organizational implementation and integration of artificial intelligence into the business. The need thus exists for a framework/model to assist businesses in determining their readiness for artificial intelligence to assist in solving these challenges. The aim/goal of the study is to develop a conceptual technology readiness model aimed at artificial intelligence. This model aims to provide two main outputs. These outputs encompass the numerical calculation of the business' readiness. The second output focuses on providing the business with the ability to categorize and prioritize readiness dimension and elements from an overall, strategic, operational and tactical perspective. The readiness model foundation is developed through the incorporations of academically rooted methodologies and systematized literature reviews. This foundational and core readiness dimensions and elements encompass 7 readiness dimensions and 42 elements, these are further validated through the use of a developed validation process, which incorporates validation steps in various sections that form part of the completion of this study. Through the application of developed requirements, the appropriate, applicable and viable subject matter experts and case study were identified for the study. The readiness model developed was aimed towards use in large enterprises. After the readiness model was developed, improved and validated, it was applied to a large real-world insurance corporation. The readiness model identified that the business's best performing dimension was the organizational governance and leadership with a score of 5.85 and the lowest dimension was Employee and culture with a score of 3.87. The use of the Importance-performance analysis prioritized the dimension that requires the most attention and resources in the short to-medium term, as the knowledge and information management dimension. The three elements within this dimension with the largest difference in performance and importance is identified as, Management information system and data processing, Enterprise resource planning in terms of databases and software and Technology knowledge management. Their respective readiness scores are 3.44, 4.375 and 3.875. The overall deduction is that the business requires more time, resources and effort as indicated in the results to consider artificial intelligence implementation. Through the conducted literature reviews, it was evident that there is a lack of academic papers, which assist businesses in the implementation and integration of AI into their business, as well as determining a business' readiness. The process of developing the model is systematically developed, followed and presented. This allows for ease of developments and improvements to the model in the future to assist businesses with the implementation of this continuous changing and evolving technology.

Opsomming

In ʼn voortdurende veranderende en ontwikkelende landskap van die besigheidswêreld, is die vinnige groei van tegnologie ʼn noodsaaklike faktor om mededingend te wees, asook om deel te vorm van waardeskepping. Een van hierdie ontwikkelende tegnologieë, is kunsmatige intelligensie. Besighede wat op hierdie tegnologie se geleenthede wil kapitaliseer, het unieke uitdagings. Een van hierdie uitdagings is die strategiese en organisatoriese implementering en integrasie van kunsmatige intelligensie in besighede. Die behoefte bestaan dus vir ʻn raamwerk/model om besighede te help om hulle gereedheid vir kunsmatige intelligensie te bepaal. Die doel van die studie is om ʼn tegnologiese gereedheidsmodel wat gemik is op kunsmatige intelligensie te ontwikkel. Die model poog om twee uitsette te lewer. Die een uitset behels ʻn numeriese berekening van die besigheid se gereedheid. Die tweede uitset verskaf die besigheid met die vermoë om gereedheidsdimensies en elemente van ʼn oorhoofse, strategiese, operasionele en taktiese perspektief te kategoriseer en prioritiseer. Die gereedheidsmodel se fondament is ontwikkel deur die insluiting van akademiese metodologieë en sistematiese literatuur resensies. Die fundamentele gereedheidsdimensies en elemente sluit in 7 dimensies en 42 elemente. Hierdie word verder geëvalueer deur die gebruik van ʼn valideringsproses, oor verskeie afdelings wat deel vorm van die voltooiing van hierdie studie. Deur die toepassing van die vereistes, is toepaslike en lewensvatbare vakkundiges en gevallestudies geïdentifiseer. Die gereedheidsmodel wat ontwikkel was, is op groot ondernemings gemik. Na die gereedheidsmodel ontwikkel, verbeter en gevalideer was, was dit by ʼn internasionale versekeringsmaatskappy toegepas. Die gereedsheidsmodel het bewys dat die beste presterende dimensie organisatoriese bestuur en leierskap was, met ʼn telling van 5.85. Die laagste dimensie was werknemer en kultuur met ʼn telling van 3.87. Die prestasie analise het die dimensie wat die meeste aandag en hulpbronne in die kort- na mediumtermyn benodig, geïdentifiseer as kennis en inligtingsbestuur. Die drie elemente in hierdie dimensie met die grootste verskil in prestasie en belangrikheid is bestuursinligtingstelsels en data verwerking, hulpbronbeplanning in terme van databasisse en sagteware asook bestuur van tegnologiese-kennis. Die onderskeie gereedheidstellings is 3.44, 4.38 en 3.88. Die algehele gevolgtrekking is dat die besigheid meer tyd, hulpbronne en moeite moet aanwend, om kunsmatige intelligensie te implementeer. Deur die literatuur oorsig is dit duidelik dat daar ʼn tekort van akademiesebronne is wat besighede met implementering en integrasie van kunsmatige intelligensie ondersteun. Die gereedheidsmodel se sistematiese ontwikkelings stappe maak dit eenvoudig en maklik vir toekomstige ontwikkeling en verbeterings. Die voortdurende verbeterings en ontwikkeling aan die gereedheidsmodel kan besighede ondersteun met die implementering van hierdie veranderende tegnologie in die toekoms.

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I would like to deeply thank my study leader Prof. Sara Grobbelaar, who always showed great enthusiasm, guidance and patience even during difficult times. I could have not completed this thesis without her support. I would also like to express a deep appreciation to both my parents. For their patience, expert and wise guidance and many years of support. Also, I express my appreciation to friends and family for their unconditional support. Finally, I want to thank my Creator, for being with me through this research study and blessed me with knowledge and skills to be able to complete it.

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List of acronyms and abbreviations

AI – Artificial intelligence

BPM – Business process management

CFA – Conceptual framework analysis

GTM – Grounded theory methodology

IPA – Importance performance analysis

CMM – Capability maturity model

CMMI – Capability maturity model integration

Chapter 1: Introduction

Chapter 1 focuses on the basic aim and necessity of this study. It does this through identifying the background to this study and the research problem and develops the project objectives. The scope of the study and its ethical implications are determined and a broad description of the project, outlining chapters and their contents, is provided. This first chapter thus forms the initial basis of this study, which the following chapters further develop and complete.

Chapter 1 Objectives	Provide introduction and background on project
	Conduct a theory and literature analysis
	Develop problem statement
	Develop project objectives
	Describe expected project contribution
	Describe expected ethical implications of the study
	Outline proposed content breakdown

1.1 Background of study

Artificial intelligence (AI) is defined as the ability of computer systems to display intelligence. AI is being used to improve the efficiency and quality of operations and systems in various sectors ranging from energy, education, transport to health. Artificial intelligence is a primary driver of the 4th industrial revolution, which is the development of technologies that combine the biological, digital and physical worlds (Skilton, 2017).

The field of AI is generally seen to have started at conference at Dartmouth College in July 1956, where the phrase of artificial intelligence was first used (Brunette, Flemmer and Flemmer, 2009). Many leaders in the field of AI attended the conference and some of these later opened up centres for AI research, such as at MIT, Stanford, Carnegie Mellon University and Edinburgh (Brunette, Flemmer and Flemmer, 2009). By the 1980s, a general understanding had arisen that AI was more complicated than first thought (Brunette, Flemmer and Flemmer, 2009). Recently, due to improvements in the technologies associated with robots and computing, there have been broad attempts to build embodied intelligence (Brunette, Flemmer and Flemmer, 2009). The improvement of technologies associated with robotics and computing has enabled the growth in AI methods, such as machine learning, natural language processing, image recognition and deep neural networks. Systems that incorporate Artificial intelligence have the potential to either surpass or match human level performance in an ever-increasing number of domains and are driving rapid advances in other technologies (Brynjolfsson, Rock and Syverson, 2017). Artificial intelligence is evolving and whether AI is used to imitate complex or human level tasks, work will be driven by the quality of models of computation (Skilton, 2017).

AI is poised to have a transformational impact on businesses. Globally many companies are using AI, but the greatest opportunities are still to be capitalized on. The effects of AI will be clearer as sectors such as, finance, health care, law, advertising, insurance, entertainment, education, transportation and manufacturing transform their business models and core processes (Brynjolfsson and Mcafee, 2017). A major improvement in AI applications are cognition and problem solving (Brynjolfsson and Mcafee, 2017). Some examples of cognitive or AI technologies are machine learning, natural language processing, rule engines, robotic process automation and deep learning neural networks (Davenport, Loucks and and Schatsky, 2018). These AI technologies are further described in the table below:

Table 1. AI and cognitive Technologies (Davenport, Loucks and and Schatsky, 2018).

AI Technology	Description
Machine Learning	These statistical models develop capabilities and improve over a period of time without the need to follow direct programmed instructions (Davenport, Loucks and and Schatsky, 2018).
Natural Language processing	Extracts/generates intent and meaning from text in a grammatical and readable way (Davenport, Loucks and and Schatsky, 2018).
Rule Engines	It is the automation of processes by using databases of knowledge and rules (Davenport, Loucks and and Schatsky, 2018).
Robotic Process automation	This technology is software that automates rule-based and repetitive processes (Davenport, Loucks and and Schatsky, 2018).
Deep Learning Neural Networks	This technology is a complex form of machine learning with neural networks and many layers of abstract variables. These models work well for image recognition (Davenport, Loucks and and Schatsky, 2018).

The AI solutions are beginning to approach and surpass human-level capabilities with regards to specific real-world tasks. The developing and maturing AI technologies are powering existing industries, such as high-speed trading, web searches and commerce. These technologies assist in the development of new industries around augmented reality, biotechnology, autonomous vehicle and IoT (internet of things) (Stoica *et al.*, 2017). An example of AI technology is Google's DeepMind. By using machine learning systems, the Deep Mind team improved the cooling efficiencies at data centres by more than 15%, even after experts had optimized the systems. Intelligent agents are being used by Deep Instinct cyber security companies to detect malware and by PayPal to prevent money laundering. Machine learning systems are not only replacing older algorithms in applications but are superior in tasks that were previously done best by humans (Brynjolfsson and Mcafee, 2017).

Analysis in a study conducted by PwC, Fraunhofer and Forbes indicated a 14% increase in global GDP by 2030 as a result of increasing development and adoption of AI. This is estimated to amount to $15.7 trillion. The economic impact of AI will be driven by productivity growth as businesses increasingly automate their processes and integrate their existing work force with AI technologies. This will lead to an increase in consumer demand due to the availability of personalised and higher quality AI services and products (Rao and Verweij, 2017).

Based on PwC's AI impact index evaluation, the figure below indicates the estimated adoption maturity percentage over short, mid and long term for different sectors (Rao and Verweij, 2017). The main adoption sectors are healthcare, automotive, financial services, transport and logistics, energy, retail, manufacturing and technology, communication and entertainment. The subsectors within each of these main sectors are identified in the table below.

Table 2. Subsectors of main adoption sectors (Rao and Verweij, 2017).

Sector	Subsectors
Healthcare	• Health services • Life sciences • Consumer Health • Insurance
Automotive	• OEM • Financing • Component Suppliers • Aftermarket & Repair
Financial Services	• Insurance • Capital and Banking • Asset Wealth Management
Transport and Logistics	• Logistics • Transport
Technology, Communication and entertainment	• Technology • Media and communication

Energy	• Utilities and Power • Gas and oil
Retail	• Retail • Consumer Products
Manufacturing	• Industrial products and raw materials • Industrial manufacturing

The adoption maturity percentages of the different sectors are presented in Figure 1 below. The basis of analysis with regards to this index evaluations is divided into two section. These sections are AI impact index and economic analysis. For the impact index, sector specialists, market participants and partnerships with Fraunhofer together identified and evaluated use cases through the incorporation of five criterions. These criterions are (Rao and Verweij, 2017):

- Potential to enhance quality
- Potential to enhance consistency
- Potential to enhance personalisation
- Potential to save time for consumers
- Availability of data to enable gains

The derivation of scoring parameters for each criterion was completed. This was followed by the evaluation of technological feasibility. The results together were used to determine the possible time to adoption, possible barriers and how to overcome these barriers. The different maturity adoption terms are divided into short term (0-3 years), mid-term (3-7 years) and long term (7+ years). This provides some insights into possible areas of focus for AI in different business sectors, for different time frames. The different sectors and their adoption maturity percentages with regards to short, mid and long term can be seen in the figure below. can be seen in Figure 1.

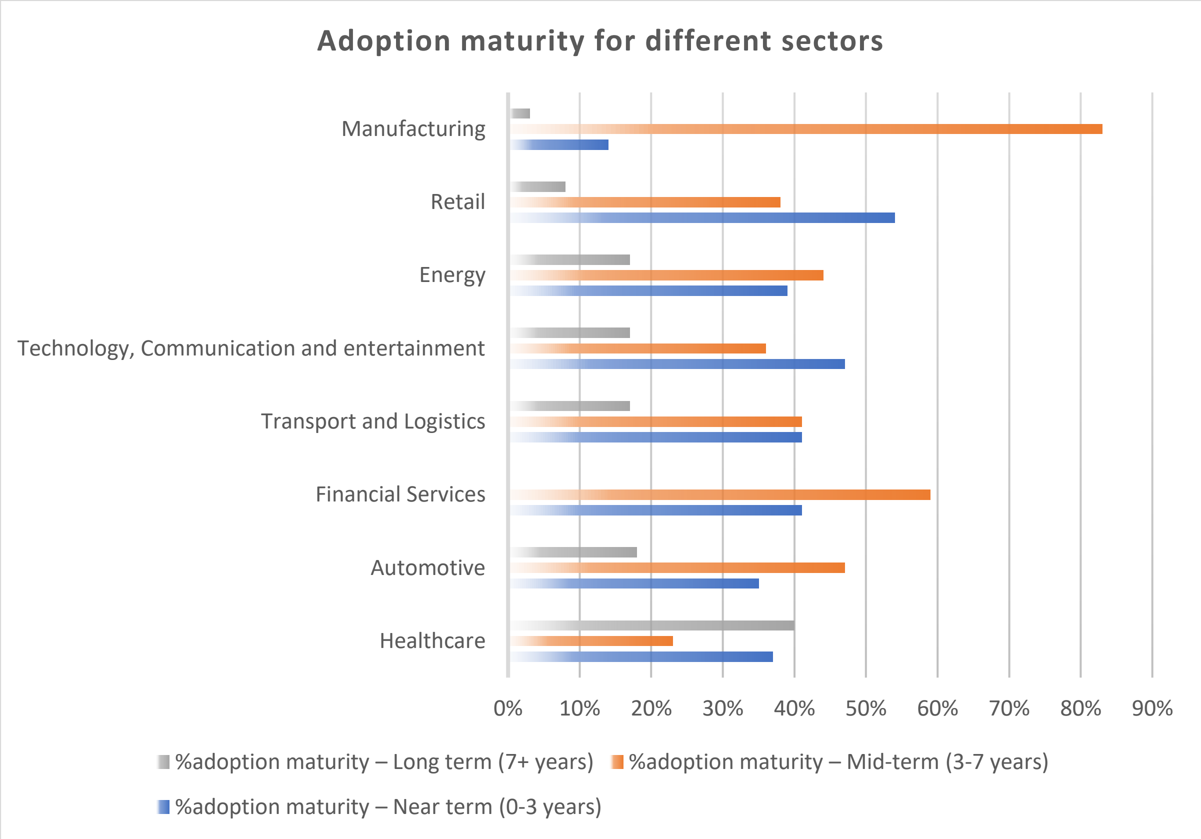

Figure 1. Adoption maturity for different sectors (Rao and Verweij, 2017)

Figure 1 indicates that there are large percentages of AI adoption currently happening and in the near future (short term), such as retail, energy, technology, communication and entertainment, transport and logistics and financial services. This indicates that the adoption of AI into businesses in different sectors will continue to grow. The recent success of AI can be contributed to three main features, these being integration of massive amounts of data, scalable computer and software systems and the broad accessibility of these technologies allowed core AI architecture and algorithms such as deep learning, reinforcement learning and Bayesian inference to developed and explored within various problem domains (Stoica *et al.*, 2017).

Although businesses will face many challenges when adopting AI into their business structure, effective implementation and integration of Artificial Intelligence could be invaluable in terms of costs and time to production. 250 Executives that are familiar with the concepts and applications of AI technologies (cognitive aware) were surveyed on what the top challenges are with regards to cognitive technology in (Davenport, Loucks and and Schatsky, 2018). The results can be seen in Figure 2.

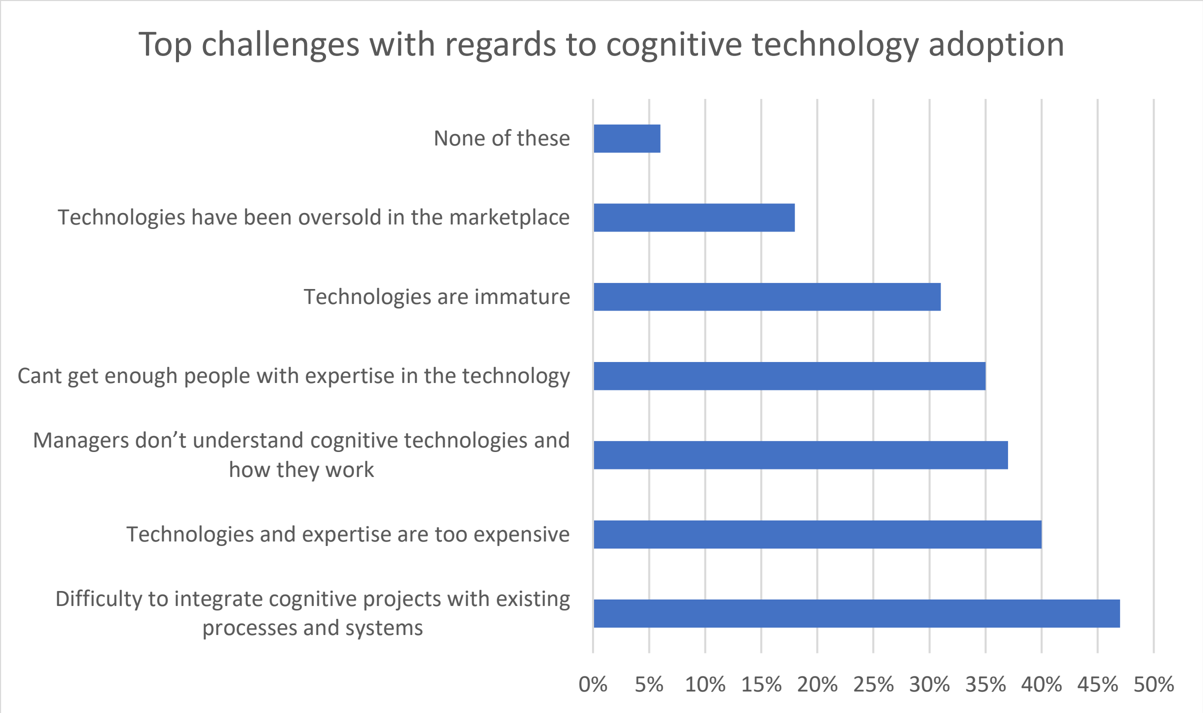

Figure 2. Organizational challenges towards AI (Davenport, Loucks and and Schatsky, 2018)

From the data in the figure above, it is clear that the implementation or integration of AI technologies is seen as the greatest challenge towards adopting AI processes (Davenport, Loucks and and Schatsky, 2018). From the Gartner's 2019 CIO agenda survey, three main adoption barriers were identified for AI, these adoption barriers are enterprise maturity, fear of the unknown and finding a starting point (Goasduff, 2019). The study (Sun and Medaglia, 2019) further identified definitive challenges with regards to the adoption of AI in the public sectors and there have been few studies that adopted a theoretical lens to capture the perceptions of challenges with regards to AI (Sun and Medaglia, 2019). The study also identified challenges with regards to issues on a strategic level with regards to AI (Sun and Medaglia, 2019). These concerned a business' digitization with regards to digital technologies, such as robotic process automation and AI (Lamberton, Brigo and Hoy, 2017). It is evident that the general perception is that the strategic planning, initiation and implementation of AI poses challenges. The implementation and integration of AI in business is a complex problem, as only a part of it involves business maturity and readiness to implement Artificial Intelligence.

An important aspect towards implementing a new technology is managing the expectations around this technology. Failure to do so could lead to severe delays in productive implementation and operation of this technology. The Gartner Hype Cycle demonstrates how expectations revolve around Artificial intelligence. The Gartner hype cycle provides a cross-industry perspective and identification of trends on technologies, which business strategists, entrepreneurs, global market developers, emerging-technology teams, chief innovation officers and R&D leaders should consider when developing their emerging-technology portfolios (Gartner., 2018). The hype cycle focuses on technologies that show promise in terms of delivering a high magnitude of competitive advantage between five to ten years (Gartner., 2018) and it graphically depicts the adoption and maturity of technologies and applications. These include the technologies' potential relativity towards solving and exploiting real business problems and opportunities (Gartner, no date).

Each Hype Cycle is divided into five key phases: innovation trigger; peak of inflated expectations; trough of disillusionment; slope of enlightenment; and plateau of productivity. These are illustrated in Figure 3 below. The innovation trigger phase is characterized by early 'proof of concept' stories, as well as media interest which triggers compelling publicity. These technologies are usually unproven in terms of commercial viability and useable products (Gartner, no date). The peak of the inflated expectations phase is characterised by publicity, which produces some success stories as well as many failures (Gartner, no date). The trough of disillusionment phase is characterised by loss of interest due to the failure of experiments and products. Investments nevertheless continue, on the condition that providers improve the products to the satisfaction of the early adopters (Gartner, no date). The slope of enlightenment is characterised by an increase in companies that fund pilots because more instances which demonstrate how technology can benefit business lead to greater understanding (Gartner, no date). The plateau of productivity is characterised by the increase in mainstream adoption and provider viability criteria is more clearly defined.

Advantages of using the Gartner Hype Cycle include helping to separate technological hype from commercial hype. This reduces the decision risk for technology investment and makes it possible to compare personal views on a technology's business value with the perspectives of IT analysts (Gartner, no date). All this is illustrated in the figure below which displays AI types such as deep neural networks (deep learning), AI Paas, Edge AI, general Artificial Intelligence and deep neural network ASICs. It is evident that according to Gartner hype cycle methodology view that these types of emerging technology are still within the innovation trigger and peak of inflated expectations phases. This is particularly true of deep neural networks, a technology which has the highest expectations within the peak of inflated expectations. This suggests that there is still progress to made in terms of understanding and developing AI in order to produce an effective and efficient environment in which to implement and operate this technology.

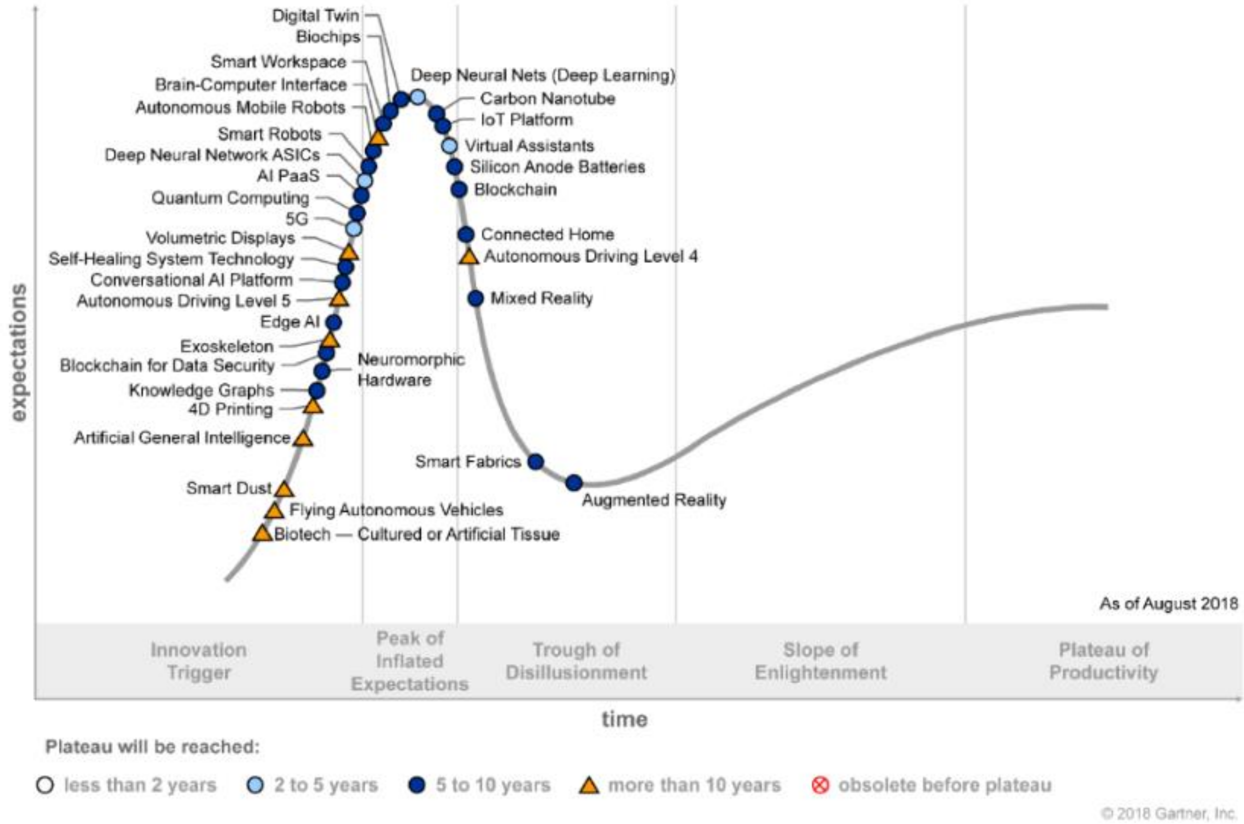

Figure 3. Gartner hype cycle of emerging technology 2018 (Gartner., 2018)

One of the five emerging trends identified is democratised AI (Gartner., 2018). This trend is described as the availability of AI to the masses. The movement of cloud computing, "maker" communities and open sourcing is driving for widely available (democratised) AI (Gartner., 2018). This supports the idea that a model or framework is needed to identify the groundwork foundations and requirements that are initially needed to implement this technology. This will contribute to the body of literature thus increasing general knowledge of the field of Artificial Intelligence in business.

From this background analysis on Artificial Intelligence, it is evident that this technology is integral to the 4th industrial revolution and will have a considerable impact on business across many sectors from short to long term. This further emphasises the importance of the successful implementation and integration of this technology. However, inflated expectations and misconceptions remain, thus a study targeting at overcoming this barrier will be of great value for the future.

1.2 Research problem Statement

Businesses aiming at implementing AI in their business structure or providing AI services face a range of challenges, particularly the difficulty of implementation. Even as businesses change and transform their business models and processes to capitalise on the advantages of machine learning, business imagination, management and, most importantly, implementation of AI create bottlenecks to progress (Brynjolfsson and Mcafee, 2017). In order for a business to initiate the complex process towards effective integration and implementation of AI, the focus needs to shift to the starting phases of such an undertaking: the maturity or readiness of a business for AI. Some important aspects to think about are how a business determines its level of maturity or readiness towards implementing AI into their business structure and what the current level of maturity or readiness is.

Table 3. Research problem questions.

Research Problem Questions
How to determine a business' readiness for AI?
What are the different dimensions or components of AI readiness?
What are the different views of readiness for a business with the focus on AI?
What are the characteristics and items of each AI readiness dimension?

1.3 Project Objectives, scope and limitations

The aim of this project is to develop a generic Artificial Intelligence readiness model for businesses by determining business readiness. This model should consider different dimensions as well as rank different business areas in order of importance. The readiness model provides crucial initial steps towards an Artificial Intelligence integration method and procedure. The previous section suggested that businesses wishing to implement Artificial Intelligence technologies find initiation of the process a significant challenge. This creates a major adoption barrier for many companies. The readiness model provides insights into how and where a business measures its readiness for Artificial Intelligence implementation, thus identifying the areas that will require the most attention in order to increase readiness. To meet the main objective of this study, the following objectives need to be addressed:

- Identify literature with the focus on AI readiness in business
- Develop systematized literature review.
- Developing a conceptual readiness model
- Validate conceptual readiness model
- Identify applicable, real-world case study.
- Apply validated readiness model to viable and applicable cases study

The main scope of the project is to develop a readiness model comprising dimensions and elements retrieved from various literature sources in order to form a generic technology readiness model. The model focuses on Artificial Intelligence implementation by accumulating applicable readiness dimensions and elements and draws on a systematised literature review in combination with the most appropriate methodology. The model's scope encompasses ways to develop a generic, robust, technology-readiness model aimed at Artificial Intelligence, as well as generic business dimensions that are required to implement the new technologies. The AI readiness model validation consists of the use of a case study that incorporates views and expertise across business and industry, as well as SME interviews to ensure the accuracy, effectiveness and robustness of the model developed.

The main aim of this research study is to develop a conceptual technology readiness model that is focused on Artificial Intelligence implementation in business. The study limitations with regards to this study are:

- Within this management tool, the "performance" evaluation dimension derived from this study, which is used to determine the business' readiness in the case study is based on the satisfaction of individuals, thus it is not specifically performance based.
- The readiness model was applied to one large insurance corporation.
- The determination of the case study business' readiness for artificial intelligence was developed from feedback received from 9 individuals regarded as experts in their fields, however they were all employed within one large corporation. Future studies ay thus expand and test the usability and completeness of the framework in other contexts.
- Seven subject matter experts with regards to AI and robotic process automation implementation was included in this study.
- The developed readiness model is conceptual in nature, thus further research, evaluation and development from experts would be required to develop a generic business readiness model for more specific types of AI, across different businesses.

1.4 Expected Contributions

The outcome of this study is to create a robust and generic Conceptual Readiness model. This will help businesses determine their level of readiness for the integration of Artificial Intelligence into their business structure, as well as identify shortcomings. The readiness model contributes towards the complex challenge of integrating and implementing Artificial Intelligence into a business. The initial literature analysis identified a gap in research in the field of frameworks that support the implementation and integration of AI at an enterprise and organisational level. Beneficiaries from this study are organisations and businesses wishing to incorporate, or provide services which incorporate, Artificial Intelligence. Researchers and individuals employed in the field of AI, technology management, enterprise engineering, emerging technologies, industrial management and general engineering could also benefit.

1.5 Ethical implications of the research

Ethical clearance for this research was required because it involved interviews and surveys with subject matter experts and the individuals who are part of the case study. The researcher was required to adhere to all ethical requirements as set out by Stellenbosch University. Although the information gathered falls within the low risk category, it is handled anonymously and confidentially. Ethical clearance and institutional permission to conduct and complete the study were obtained. The following stipulations were addressed to ensure anonymity, confidentiality and protection of individuals and the data gathered:

- The information that was gathered from individuals, were labelled and remained completely anonymous throughout the study
- The participation in this study was completely voluntarily and the participant was free to withdraw from the study without any negative consequences
- If the participant wished to withdraw from the study, the data gathered from the specific participant through the interview/survey would be permanently deleted/destroyed
- The participants were also free to refuse to answer questions they do not feel comfortable with
- All physical documents and information regarding the interview and physical survey was securely stored in the faculty of the university
- The information obtained from the interviews and surveys was considered as opinion/insight rather than fact
- The business that was approached for the case study, remained anonymous as well, to protect individuals

1.6 Proposed research content breakdown

The table below describes the high-level study approach taken towards the completion of the project. The expected outcomes and skills of each section are indicated below, thus providing a simple guide to the proposed study.

Table 4. Proposed research content breakdown

Chapter 1 Introduction	Project background description
	Problem statement description and project objectives
	Conduct literature and theory analysis
	Project scope description and expected contributions
	Identify project timeline
	Apply business plan development skills
	Apply researching skills
Chapter 2 Methodology	Identify appropriate tools and methods to develop an AI readiness model in the context of the project

	Identify the most viable methodology method for the study
Chapter 3&4 Literature reviews	Identify viable decision support tools
	Research the implementation of AI into business
	Research different AI technology maturity levels and activities
	Research on developing maturity and readiness models
	Apply decision making skills
	Conduct systematized literature reviews
	Conduct narrative literature reviews
Chapter 5 Development of readiness components	Organize and illustrate readiness components in terms of dimensions and elements
	Develop the readiness elements
	Identify readiness variables within the elements
Chapter 6 Development of the readiness model	Identify the readiness model process/operation steps
	Identify validation processes and mechanisms
	Develop the readiness model weightings
	Develop calculations to determine business readiness for AI
Chapter 7 Conduct case study	Develop requirements regarding case study
	Identification of viable case study
	Provide background information on case study
	Conduct case study
	Analyse the case study results
Chapter 8 Conclusion	Provide a conclusion of the case study results
	Provide insights into the applicability of the model
	Provide insights into the advantages and disadvantages of the model
	Provide possible future developments and improvements of the model

The background study of the project provided the principal information about the increased growth and adoption of Artificial Intelligence technology. Successful implementation of AI technology provides businesses and companies with competitive advantages and increased production and productivity. The increase in adoption maturity percentages shows increasing interest from businesses. However, those businesses wishing to capitalise on this technology face a number of challenges. Of these, the implementation and integration of the Artificial Intelligence technology is one of the greatest. The development of an AI-readiness model enabled the initialisation of a process that will assist in solving the complex challenges which businesses face. The model aimed to assist in the successful integration and implementation of AI technology by identifying readiness dimensions and elements, as well as indicating shortcomings in the business. The outcome of this project should help businesses and researchers involved in the field of Artificial Intelligence grow their understanding as we move towards the 4^{th} industrial revolution.

Chapter 2: Methodology

The methodology chapter explains the rationale behind using specific procedures and techniques, which were used for the identification, selection, processing and analysis of information related to understanding the research problem (USC, 2017). Chapter 2 presents the exploration and selection of various methodologies. Advantages and disadvantages of the methodologies are weighed up to gain clarity on their viability.

Chapter 2 Objectives	Identify applicable methodologies
	Describe each identified methodology
	Provide advantages and disadvantages of each methodology
	Select the most appropriate and viable methodology
	Discuss literature review methodologies

2.1 Main research approaches

Conducting research, usually involves two main research approaches namely, quantitative and qualitative. These approaches can be combined to form a mixed methods approach (Diriwächter and Valsiner, 2006). Inductive and deductive reasoning formed an important part of better understanding the research strategy appropriate for this project. The basis of grounded theory methodology comprises the conjunction of deductive and inductive reasoning (Datt, 2016). These concepts will be explored in the following sections.

2.1.1 Qualitative and Quantitative research

There are different definitions for qualitative research. One is that it is "Empirical research where data is not in the form of numbers" (Punch, 1998). Another definition is that, qualitative research is multi-methodological in method, which incorporates a naturalistic and interpretive approach to its subject matter (Crozier, Denzin and Lincoln, 1994). This indicates that qualitative researchers study phenomena's, which are given meaning by people in their natural settings, through attempts of interpretation (Crozier, Denzin and Lincoln, 1994). This research approach is exploratory in nature (Corbin and Strauss, 1990). Among the data collection methods used are document analysis, multi-case studies and semi-structured interviews with groups and individuals (Denzin, 1994). Interview respondents are carefully chosen according to their field of expertise, to enrich chosen studies.

Quantitative research can be defined as research that gathers numerical data, which can be put into rank orders, categories or be measured in units of measurement (Punch, 1998). Another definition is that quantitative research is a systematic empirical investigation of observable phenomena through the use of mathematical, computational or statistical techniques (Given, 2012). The objective of this method is the collection of numerical data and application of mathematically based models, methods, hypotheses and theories to explain a phenomenon (Aliaga and Gunderson, 2000),(Bhawna and Gobind, 2015). Data that is not in a numerical format, such as opinions and behaviours need to be quantified through the use of data collection methods like surveys and interviews. Researchers who use quantitative analysis draw conclusions from evidence, logic and argument (Trochim, 2006). The key differences between quantitative and qualitative research can be seen in the table below.

Table 5. Differences between qualitative and quantitative research (Celano, 2014)

	Qualitative research	Quantitative research
Type of knowledge	Subjective	Objective
Aim	Explanatory and observational	Generalisable and testing
Characteristics	Flexible	Fixed and controlled
	Contextual portrayal	Independent and dependent variables
	Dynamic, continuous view of change	Pre- and post- measurement of change
Sampling	Purposeful	Random
Data collection	Semi-structured or unstructured	Structured
Nature of data	Narratives, quotations and descriptions	Numbers and statistics
	Value uniqueness, particularity	Replication
Analysis	thematic	Statistical

Qualitative and quantitative research differ in purpose, data collection, approach and independence of the researchers (Bryman *et al.*, 2014). (Creswell, 2009). (Zikmund, 2003). The differences can be seen in the table below.

Table 6. Differences between qualitative and quantitative research (Bryman *et al.*, 2014), (Creswell, 2009), (Zikmund, 2003).

Component	Qualitative research	Quantitative research
Purpose	Focus on discovery and understanding of ideas/phenomenon	Test research questions or hypothesis
Approach	Observation and interpretation	Measurement and testing
Data Collection	Unstructured and rich data	Structured and hard data

Researcher independence	Researcher intimately involved	Objective results and researcher uninvolved
Most often used in	Exploratory research designs	Descriptive and casual research designs
General approach	Descriptions and words	Measurements and numbers

The insights gained into these research approaches provides the researcher with a better understanding, in determining/developing a more applicable and accurate research methodology for the study. Mixed methods combine qualitative and quantitative research methods (Diriwächter and Valsiner, 2006). The motivation for adopting this research approach is due to the additional insights that could be obtained through the combination of these methods (Creswell, 2009).

2.1.2 Grounded theory methodology

GTM (grounded theory methodology) has systematic and flexible guidelines towards the identification and integration of 'categories of meaning' from systematically gathered data points (Strauss and Corbin, 1994), (Charmaz, 2006), (Glaser, 2013). Category integration and identification can be seen as the 'method' of the methodology and the end product or 'theory' of the methodology can be seen as the developed framework, to assist in understanding the phenomena being investigated (Glaser, 2013). Reviewing the data enables the categorization and identification of themes and concepts, which could form the basis for a novel theory (Allan, 2003). The GTM strategy incorporates both inductive and deductive reasoning (Glaser and Strauss, 1967). The process of GTM can be seen in the figure below.

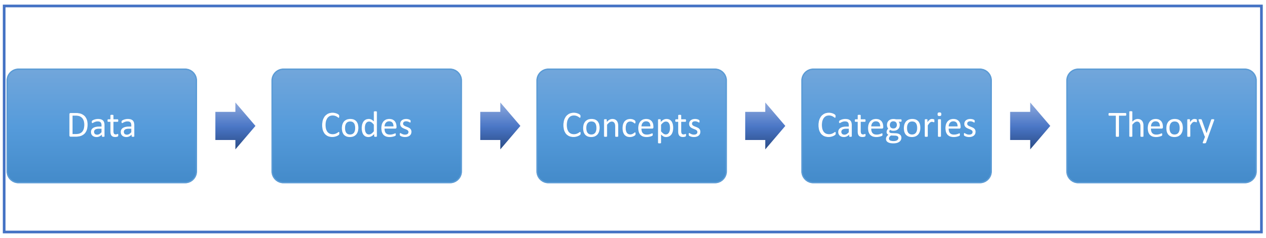

Figure 4. GTM process steps (Allan, 2003)

GTM is widely recognised as the foundation for developing a conceptual framework (Jabareen, 2009), (Astalin, 2013). Studies, which incorporate the use of the grounded theory methodology require the collection of qualitative data to initiate the process (Allan, 2003), (Saunders, Lewis and Thornhill, 2016). The methodology of the study can be seen in the figure below.

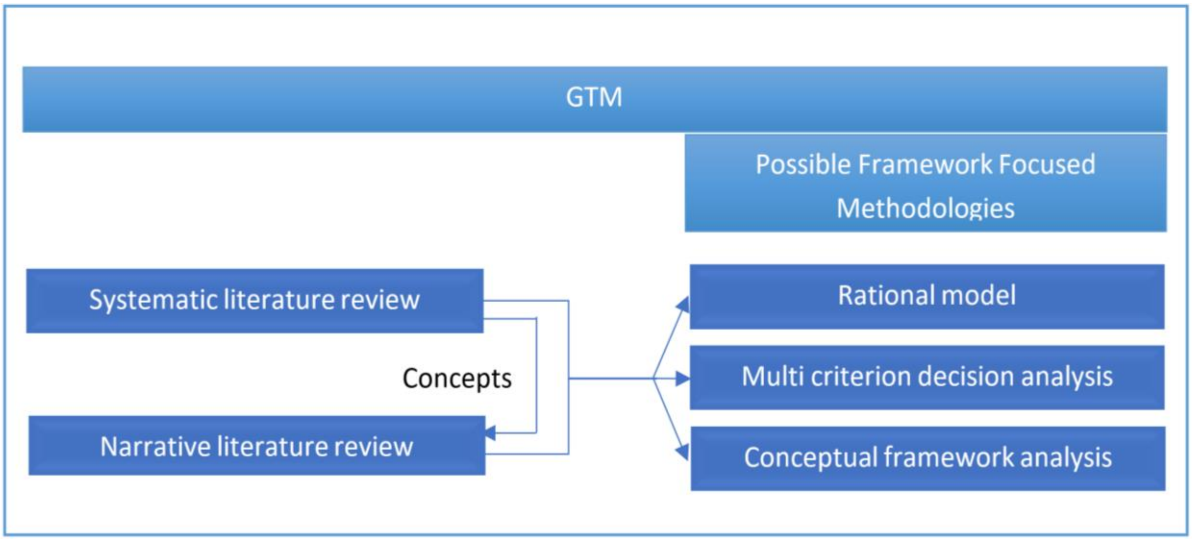

Figure 5. Initial proposed study methodology

From the figure above it is clear that GTM (grounded theory analysis) forms the basis/foundation on which the study is built. The systematized and narrative literature reviews provide the data required to further progress in the GTM methodology in order to develop and complete the framework-focused methodology in the study. In parallel with the conducting of the systematized literature reviews, concepts which were identified are used as the focus for the narrative literature reviews, which together feed into the framework focused methodology. The elaboration and evaluation of some research methodologies can be seen in the following sections. The chosen methodology will form part of the research design for this project. The systematized and narrative literature review methodologies are further explained in the following sections.

2.2 Systematized literature review

The systematized literature review is a means towards identifying, evaluating and interpreting all the available research, which is focused around a particular research question, phenomenon of interest or a certain topic area (Keele, 2007). Studies that contribute are identified as primary studies and the systematic review forms a secondary study. The aim of using a systematic literature review is to summarise existing evidence around a specific phenomenon of interest, identification of any gaps in the research, to suggest areas for further investigation and to provide frameworks to position new research activities (Keele, 2007),(Okoli and Schabram, 2012). Systematic literature reviews also serve as a method to examine the extent to which the empirical evidence contradicts or supports a theoretical hypothesis (Keele, 2007).

The advantages and disadvantages of the systematic literature review are that it’s a well-defined methodology, which means its less likely that the results of the literature is very biased. The systematic literature review can provide information on the phenomenon’s effects from a wide range of settings and empirical methods. In the case of quantitative studies, this method provides the possibility to combine data using meta-analytic data (Keele, 2007). The major disadvantage of the systematic literature review has to do with the amount of effort it requires in comparison to other, more traditional literature reviews (Keele, 2007). The features and characteristics of the systematic literature reviews are:

- The review starts by defining a review protocol, which specifies the methods that will be used and specifies the research (Keele, 2007), (Okoli and Schabram, 2012).
- The review methods employ a defined search strategy for the identification of literature (Keele, 2007), (Okoli and Schabram, 2012).
- The search strategy is documented; thus, the reader can review the study robustness (Keele, 2007), (Okoli and Schabram, 2012).
- The systematic literature review specifies inclusion and exclusion criteria; these determine the primary studies that will be included (Keele, 2007), (Okoli and Schabram, 2012).
- The review process indicates the information that will acquired from the primary studies, as well as the inclusion of quality criteria for the evaluation of the primary studies (Keele, 2007), (Okoli and Schabram, 2012).

The systematic literature review process has three main phases: planning the review, conducting the review and reporting the review (Keele, 2007). The elements within these phases can be seen in the figure below.

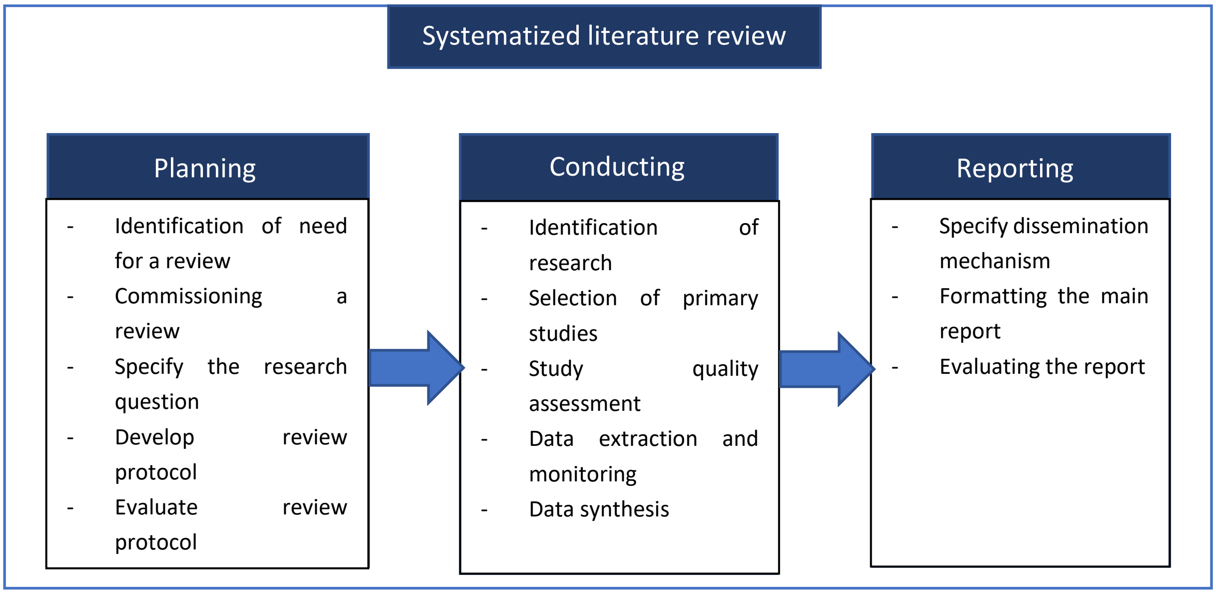

Figure 6. Systematized literature review process phases and steps (Keele, 2007).

This framework is evaluated to develop the systematized literature review methodology that was used in this study. This systematized literature review procedure can be seen in the figure below. This strategy incorporates all the significant steps of a systematic literature review.

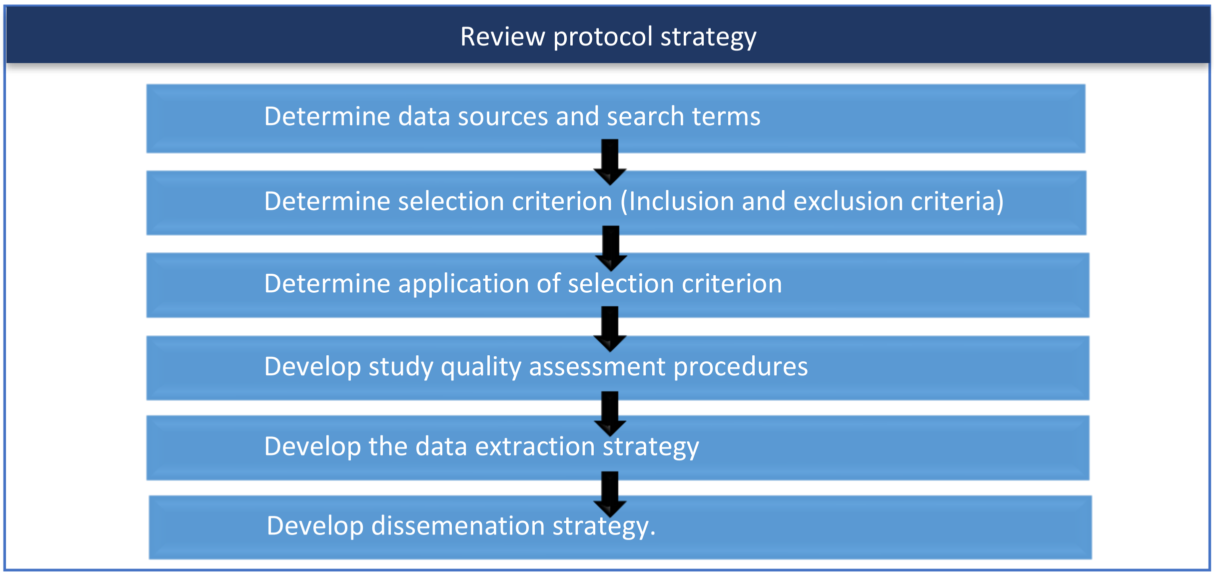

Figure 7. Systematized literature review strategy

2.3 Narrative literature review

The narrative literature review serves as a vital scientific function. Narrative literature reviews form part of many theses, articles, books, grant proposals and reviews that are focused on reviewing literature on specific topics (Baumeister and Leary, 1997). This review method summarizes a body of knowledge/literature and develop conclusions about the researched topic (Cronin, Ryan and Coughlan, 2008). The narrative literature review typically selects the material, even though the selection criteria is not always apparent to the reader (Cronin, Ryan and Coughlan, 2008). This type of literature review gathers a volume of literature in specific subject area, summarises it and synthesizes the literature (Cronin, Ryan and Coughlan, 2008).

The primary focus of this study is to provide a comprehensive background to present knowledge of the study/research area and highlight the importance of new research. This approach can develop new research questions and hypotheses by identifying possible gaps or inconsistencies within a body of knowledge (Cronin, Ryan and Coughlan, 2008). This method can assist in refining or focusing a broad research question. In this study, the research methodology incorporates both the systematized and narrative literature reviews. The decision was been made, therefore, that the systematized literature reviews will form the core of literature used in the development of the readiness model and the narrative literature review will focus on the refinement of the study.

2.4 Framework focused methodologies

The overall study methodology used is the Grounded Theory Methodology (illustrated in Figure 5 below). There are two important sub-components of this research methodology. These are the literature reviews and the framework focused methodology that will be used to determine the overall methodology used for this study. These framework focused-methodologies are incorporated to develop a more applicable methodology for this particular study rather than an overall generic methodology. The focus of this study and its model development is qualitative research and data. To some extent this affects the outcome or applicability of methodologies. Three different framework focused methodologies are described below. The advantages and disadvantages of these models are identified and a set of criteria is developed to assess the methodologies to determine the most applicable one.

2.4.1 Rational model

The rational model of decision making encompasses individuals that use information and facts, analysis and clearly defined procedures to make a decision. The rational decision making model incorporates several different processes (Uzonwanne, 2016). Regardless of the variety or number of steps within each process, the processes have similarities that usually result in effective solutions. The rational decision making model steps can be seen in the figure below.

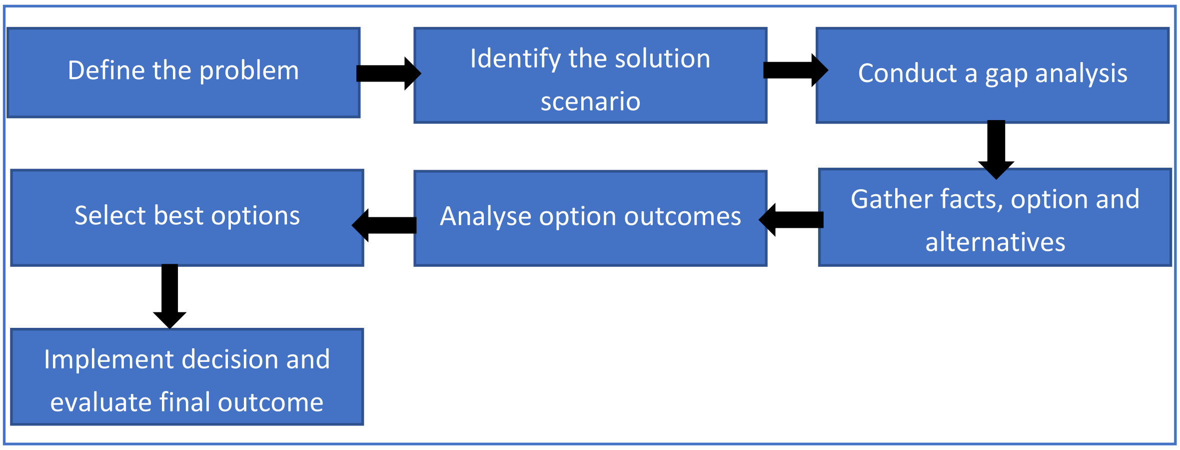

Figure 8. Rational decision making model (Uzonwanne, 2016)

2.4.2 Multi-criteria decision analysis

One characteristic of multi-criteria problems is that the information is complex. A Principle of the multi-criteria decision analysis is to assist decision makers to synthesize and organise information so that they are comfortable in decision making (Belton and Stewart, 2002). The MCDA has three main phases: the problem structuring phase, scoring phase and the preference modelling phase. Each of these phases is divided between goal and method sections, which respectively describe the goal and the methods within each phase. Two types of information flow between the problem structuring phase and the scoring phase. One set of information flowing from problem structuring phase to the scoring phase contains the hierarchical structure with decision criteria, as well as the set of decision alternatives. The second flow of information contains new information that was obtained in the scoring phase and which could possibly require the restructuring of the decision problem. The final phase is focused on formalising the decision- maker's preference structure. This identifies the best alternatives and can rank them from best to worse. However, this phase is only initiated when a dominating alternative in the decision gate process step cannot be identified or a ranking of alternatives is required. The phases of multi-criteria decision analysis can be seen in the figure below.

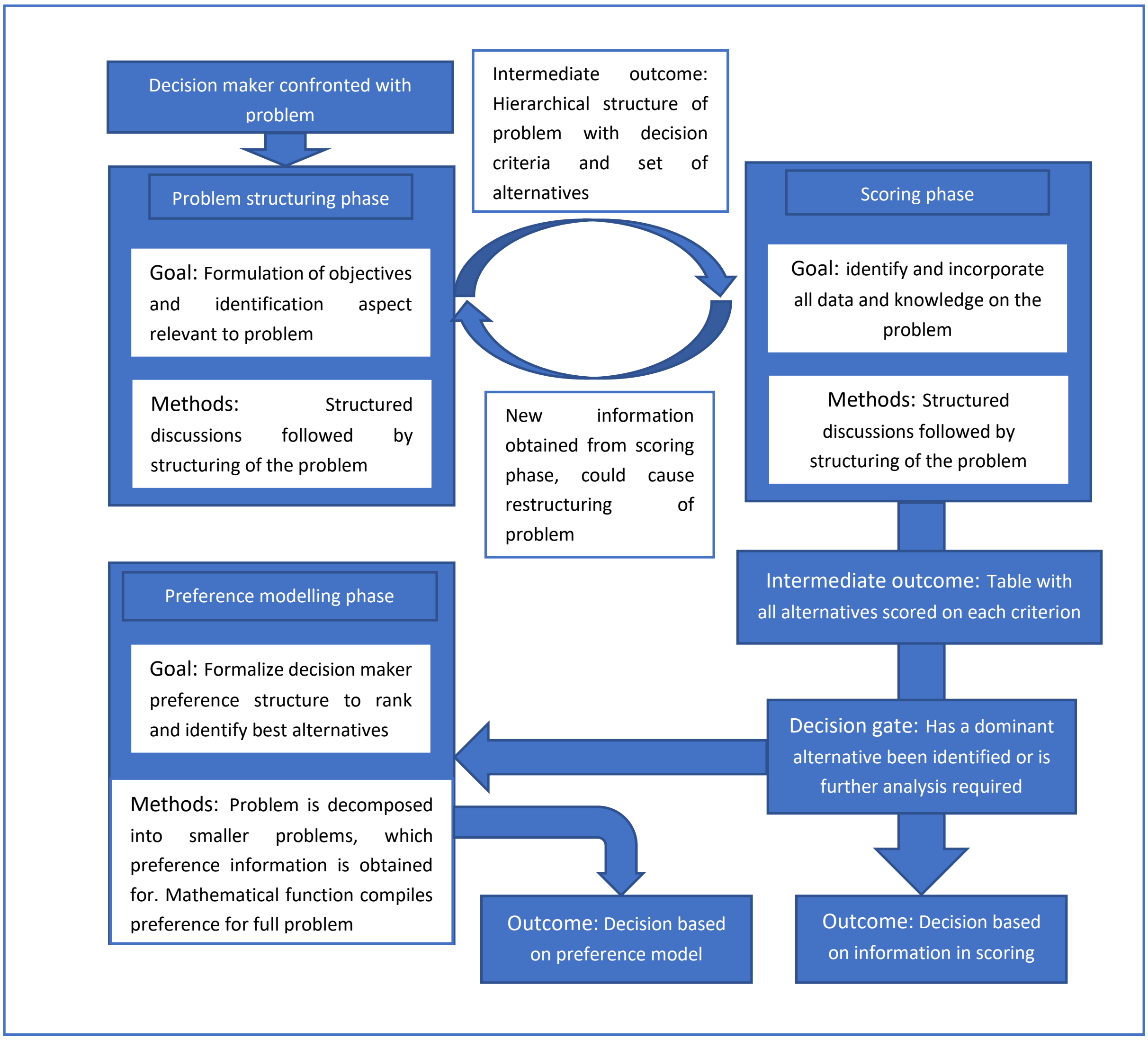

Figure 9. MCDA process steps (De Graaf, Postmus and Buskens, 2015)

MCDA is a collection of approaches that take multi-criteria into account in order to assist the user group to explore decisions which would have an impact on the situation (Saarikoski *et al.*, 2015). Scholar and academics have also recommended MCDA method for addressing intangible values (Saarikoski *et al.*, 2015).

2.4.3 Conceptual framework analysis

Conceptual framework analysis (CFA) is a theory technique, which aims to create, identify and track major concepts and events, which combined, constitutes the theoretical framework. The basis of the methodology consists of interaction among concepts induced from data, derivation and deduction aimed at hypothesizing the relationship between concepts (Jabareen, 2009). The main feature of the conceptual framework analysis is that it is not a collection of concepts, but a construct where each concept plays an important role. The method focuses on providing an interpretive approach to social reality. It provides understanding rather than a theoretical explanation, such as quantitative models. It provides a soft interpretation of intentions, rather than the knowledge of the hard facts. Conceptual frameworks are indeterminist in nature; thus, it does enable the prediction of an outcome. The conceptual frameworks can be constructed and developed through qualitative analysis. The sources of data from a range of discipline-orientated theories, which becomes empirical data within the conceptual framework analysis. The CFA consists of eight phases that follow sequentially. The phases of the CFA can be seen in the figure below.

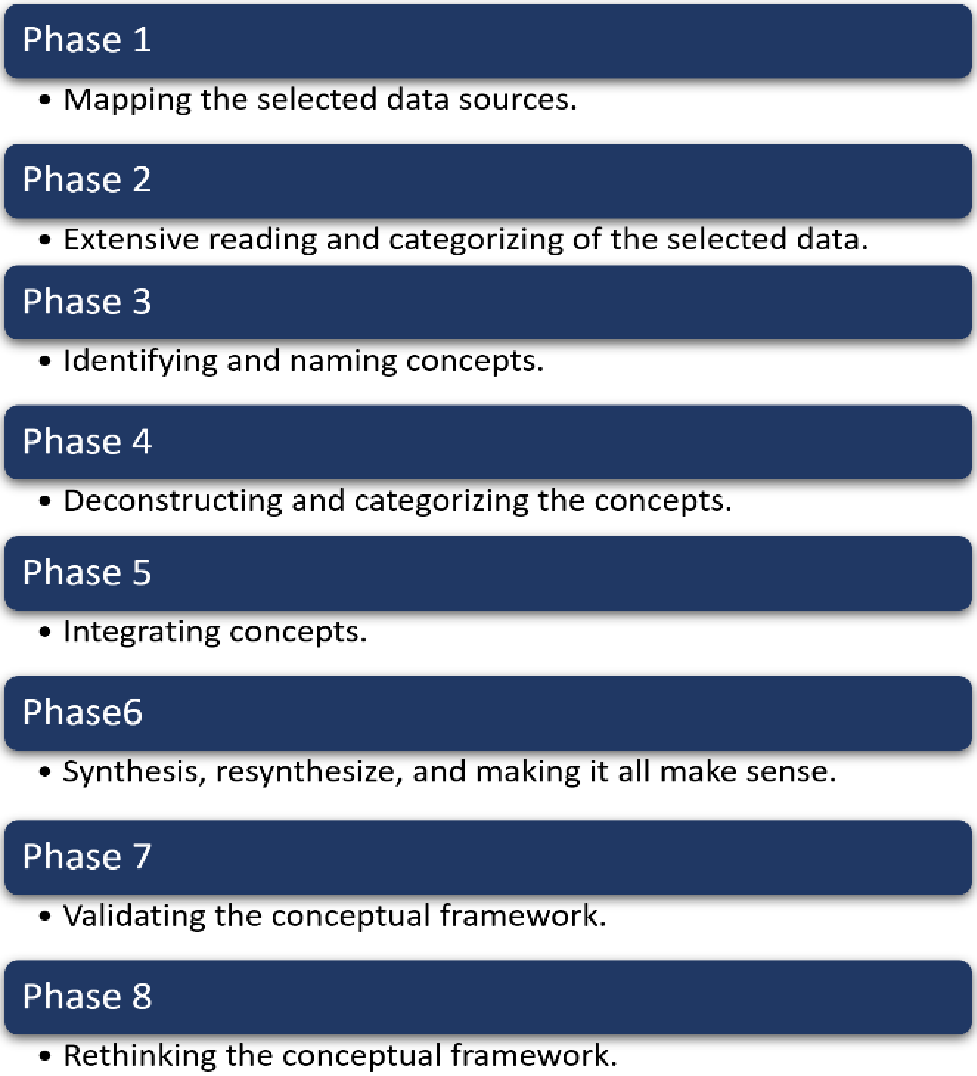

Figure 10. CFA process steps (Jabareen, 2009)

The data of the CFA should represent relevant political, environmental, social and cultural phenomena. This includes multi-disciplinary literature that encompasses the phenomenon being studied (Jabareen, 2009). The CFA process is comparative and iterative, which requires a shift between data and concepts, as well as comparing different types of evidence (Jabareen, 2009).

2.4.4 Advantages and disadvantages of proposed methodologies

To assist in the selection of the appropriate methodology, the advantages and disadvantages of the methodologies have been identified. The advantages and disadvantages can be seen in the table below.

Table 7. Advantages and disadvantages of different methodologies

Methodology	Advantage	Disadvantage
The rational (decision-making) model	• Decision process is predictable (Chaffee, 1983). • Provides relatively predictable responses (Chaffee, 1983).	• When used in isolation, results are inaccurate (Chaffee, 1983). • Results are inaccurate when insufficient range of solutions are generated (Chaffee, 1983).
Multi-criteria decision analysis (MCDA)	• Incorporates multiple stakeholder perspectives (Hongoh *et al.*, 2011). • Incorporates uncertain, subjective and qualitative information (Kujawski, 2003).	• Makes use of a single score to effectively characterize a complex problem/situation (Kujawski, 2003).
Conceptual framework analysis	• Flexibility (Jabareen, 2009). • Capacity for modification (Jabareen, 2009). • Assists in understanding a phenomenon (Jabareen, 2009).	• This methodology is not sufficient for generating theorization (Jabareen, 2009)

2.4.5 Proposed Methodology

Certain criterion had to be met in relation to the methodology towards the development and completion of this study. The table below assesses each methodology with regards to the selection criteria. This was used in combination with information from the previous section to determine the most viable methodology for this study.

Table 8. Viability of different methodologies

Criteria	Rational Model	Multi-criteria decision analysis	Conceptual framework analysis
Accommodates qualitative research	✓	✓	✓
Methodology is flexible and has capacity for modification	×	✓	✓
The methodology can be tailored for a specific problem.	×	✓	✓

Drawing on the information of the table above and the previous section, one can conclude that the conceptual framework analysis process is the most applicable and appropriate methodology for this study. A more detailed conceptual framework analysis model with regards to the study and problem statement is presented in Appendix B. The figure in Appendix B indicates the conceptual framework analysis model phases and corresponding chapters of the thesis, with short description of what the focus of each phase is. The selected research design for this study is the combination of GTM and CFA. These approaches provide a solid foundation towards the development of this study. The figure below provides an illustrative representation of the chosen research design.

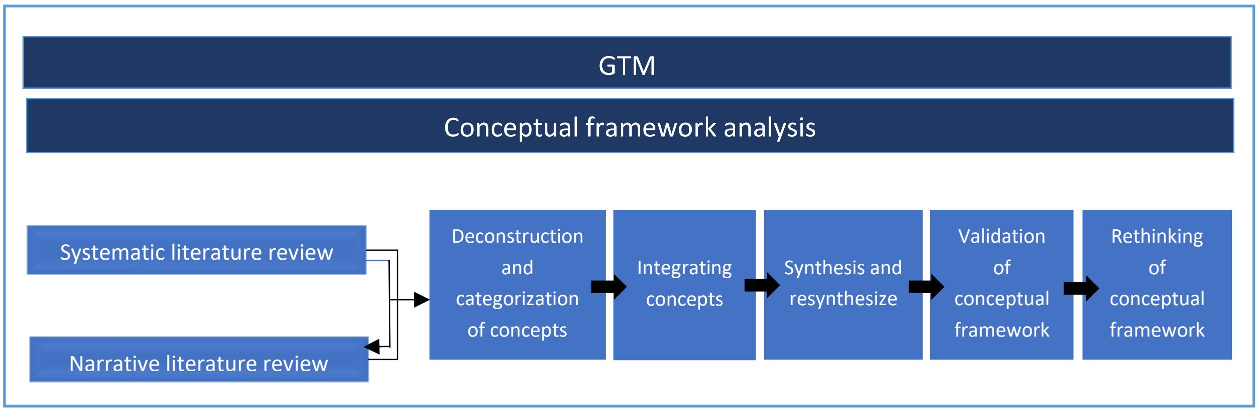

Figure 11. Study Methodology

Following the development of the research methodology that will be used in this study. The initial process steps with regards to this methodology starts with the systematic and narrative literature reviews. The following two chapters will focus on the two chosen literature reviews for this study as identified in section 2.2 and section 2.3.

Chapter 3: Narrative Literature Review

Chapter 3 focuses on the narrative literature review method. The two literature review methods used in this study are conducted in parallel. Thus, themes identified in the systematized literature reviews can be further researched in the narrative literature review section, it is important to note that the narrative literature review is more focused towards supplementing ideas and categories found in the systematized literature reviews, thus the literature in this section could seem non-sequential and high level. Narrative literature reviews form an important part of most empirical articles, theses and grant proposals (Baumeister and Leary, 1997). The general description of literature reviews is identified, followed by an initial literature search with regards to this topic followed by the main narrative literature review for this study. The figure below indicates that this section encompasses the narrative literature review process step with regards to the study methodology.

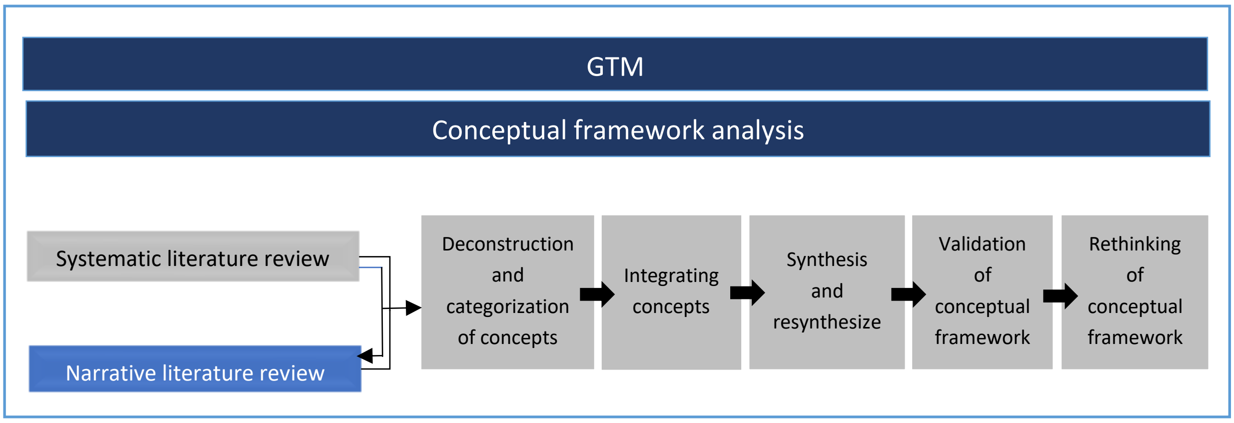

Figure 12. Study methodology process step

Chapter 3 Objectives	Conduct Initial literature research
	Present narrative literature reviews
	Identify literature to assist in the development of the readiness model
	Identify artificial intelligence specific elements and dimension with regards to readiness
	Identify maturity model literature
	Weighting methods for readiness model
	Decision support methods

The following sections serves as an initial literature scan to identify if there are existing academic literature that is similar or the same to the aim of this study. The overview of research concepts that was identified in the systematized literature review in combination with the initial literature search was completed and researched on a high level. This is illustrated in the figure below.

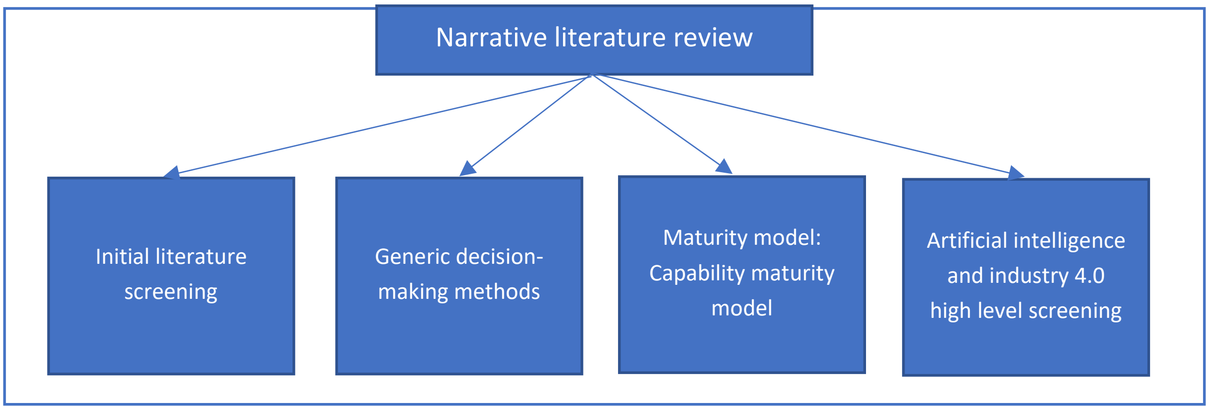

Figure 13. Narrative literature review concepts/sections

3.1 Initial literature research

The overview of relevant literature provides initial insight into what theories and information are applicable for the study. The different areas in the literature can be seen in the following sections. Relevant topics and papers are searched using certain key words. The focus of this section is gaining insights on the topic, as well as verifying that identical literature has not been developed or published.

A literature review is a detailed summary and critical analysis of literature and research that is available and relevant towards the proposed study (Cronin, Ryan and Coughlan, 2008). The type of literature review utilised is the traditional or narrative literature review. The criteria for the selection of the literature is not always apparent to the reader. This method is used, because it is useful in capturing and synthesizing the relevant literature with the aim to provide a broad background of the current literature and understanding of the topic, as well as identification of gaps in the literature (Cronin, Ryan and Coughlan, 2008). The literature review process follows the sequence seen below.

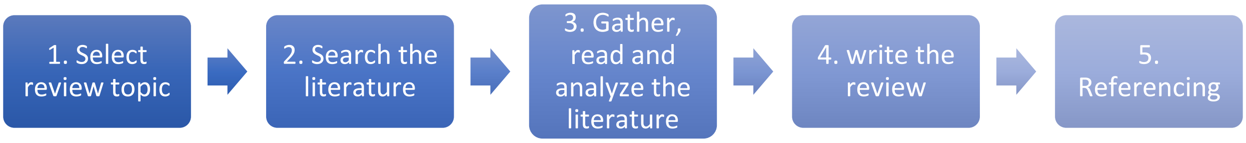

Figure 14. General literature review steps (Cronin, Ryan and Coughlan, 2008)

The first step in the literature review process has been completed in the previous chapter. The problem statement questions shown in chapter 1 provides the initial point of interest with regards to search terms are used in the search of literature.

Artificial intelligence integration research

Keywords such as artificial, intelligence, integration, readiness and model were searched in google scholar and Scopus to obtain relevant literature and studies that were done in this field. The literature provided insights into the integration of different Artificial intelligence approaches and models aimed at the creation of hybrid AI systems. The study (Corchado, 1998), summarized that research in the domain of AI is aimed to develop methods and techniques to make expert systems more efficient and provide more reasoning power. Resilient intelligent frameworks can be developed by the combination of AI techniques (Corchado, 1998). Another study of Artificial intelligence techniques and methods, which are adequate for the implementation of a computerized intelligent autonomous manufacturing environment was identified (Rotty, 1996). Overall, however, the literature stated that there is a shortage of integrated, developmental approaches for AI methods in the computer integrated manufacturing industry (Rotty, 1996).

A maturity model for assessing readiness for industry 4.0 was retrieved (Schumacher, Erol and Sihn, 2016). This document provided some insight into combining maturity models and readiness. As well as identifying important business dimensions that form part of determining the readiness of implementation of digital technologies. This model however provides only insight into industry 4.0 and not specifically artificial intelligence.

From the initial literature analysis, it was clear that there is a shortage of academic, structured, generic frameworks and models that assist businesses and companies implement and integrate artificial intelligence into their current business structures.

Maturity models, business process management and readiness models

As seen in the previous section there is a shortage of literature focused on the integration and implementation of AI, which is a large and important challenge and barrier towards adopting AI systems into businesses. The benefits of including AI into businesses are critical for businesses to compete on the local and global markets. Initial literature analysis of maturity models indicated that, in its simplest form, it is a set of patterns, indicators and characteristics that depict the achievement and advances in a particular discipline (Energy, 2012). In summary, the primary outputs of a maturity model are that it provides a starting point, a framework for prioritizing activities and provides a method to define what maturity and improvement represents for an organization (Energy, 2012).

Because a maturity models provides a possible starting point towards solving the challenges of integration and implementing artificial intelligence in businesses, the choice was made to further research this topic. Established practice has shown that a process capability profile based on a maturity model can help software-centred organisations improve and assess software processes (Von Wangenheim *et al.*, 2010).

The conclusion drawn from a systematic literature review study on software process maturity models, is that there are 29 different domains in which the development of maturity models is made for (Von Wangenheim *et al.*, 2010). Three of these models are aligned towards a generic domain of systems engineering and software, which includes acquisition, services and development (Von Wangenheim *et al.*, 2010). These three models provide important input towards developing a robust maturity model, as well as tailoring the generic attributes of maturity models, with applicable literature, to create a model which is more focused on AI implementation.

Business process management merges tools, frameworks, methodologies and objectives. These are included in a number of approaches such as business process modelling, business process automation and business process reengineering. Business process management is focused on managing processes on a continuous basis. It relies on solid systems, structural change and cultural change. Business process management is thus a holistic organizational management practice. It is interconnected with process architecture, which indicates the interrelationships between primary business processes, as well as the enabling of support processes and focusing the alignment with the goals and policies of the organisation (Rosemann and De Bruin, 2005). This could provide important insight into better understanding the effect and importance of activities within the maturity levels and their impact on other sectors of the organisation.

The initial literature searches revealed a definitive shortage with regards to readiness models and maturity models that address the implementation of artificial intelligence in businesses. The following sections focus on decision-making methods, maturity models and AI readiness models.

3.2 Generic decision-making methods

Decision-making involves making the logical and applicable choice from a list of available options. The ability to forecast the outcome of each option is an important aspect for effective decision-making (Businessdictionary, 2017). A variety of decision-making methods exist, each with its own distinguished characteristics, disadvantages and advantage. In this section, advantages, disadvantages and a description of a few decision-making methods are identified. They are presented in the table below.

Table 9. Advantages and disadvantages of decision-making methods

Decision-making method	Description	Advantage	Disadvantage
Analytical hierarchical process	Makes use of pair-wise comparisons. These are used to compare different alternatives with respect to selected criteria, as well as to estimate weightings of criteria (Velasquez and Hester, 2013)	This method is scalable, easy to use, not data intensive and easily adjustable to fit various sized problems (Velasquez and Hester, 2013)	This method has Independence of alternatives and criteria could possibly cause inconsistencies between ranking criteria and judgement (Velasquez and Hester, 2013)
Decision matrix	The matrix is used to evaluate all options with regards to a decision. The steps towards conducting this method are list all options in the first column, list all factors that affect decision in the first row; users score each option and weigh which factors are more important and determine final score of each row is determined to indicate the best option (Tools, 2017)	This method allows for the inclusion of weightings to factors and assists in removing subjectivity (It, 2017)	
T-Chart	This evaluates different options by weighing up minuses and plusses of each option (Tools, 2017)	It takes into account all negatives and positives (Decisions, 2017)	The weight of each factors is not taken into account (Decisions, 2017)

Decision Tree	The model involves the contemplation of each option and the outcomes of each option (Tools, 2017). Statistical analysis is included in the method (Tools, 2017)	This method provides a clear basis theory, strong learning ability, easy algorithm and is easy to construct (Yuxun, 2010)	This method is not suitable for handling large data sets and does not consider attribute correlation (Yuxun, 2010)

3.3 Maturity models

In their simplest form, maturity models are a set of patterns, attributes and characteristics that indicate the development and achievement in a specific domain (Caralli, Knight and Montgomery, 2012). A Maturity model provides an organization with the ability to benchmark its processes, practices and methods evaluated against a clear set of artefacts. The artefacts are usually standards and codes of best practice (Caralli, Knight and Montgomery, 2012). This ability of benchmarking can provide organizations with a view on the current level of capability and indicate the path for future improvement (Caralli, Knight and Montgomery, 2012).

In architectural terms, maturity models usually have levels on a progression scale, as well as indicating the measurable transitions between levels. Set attributes define the level. Thus, if an organisation shows a set of corresponding attributes then the organisation forms part of a certain level and inherently possesses the capabilities of that level. The summary of outputs from maturity models can be seen below (Caralli, Knight and Montgomery, 2012).

- Provides a starting point.
- Organisation benefits from community knowledge and experience.
- Provide a set meaning of improvement and maturity in the eyes of the organisation.
- Provide a framework and roadmap to prioritise actions and increase maturity.
- Provide a measurement for auditing and benchmarking (Proença and Borbinha, 2016).

The benefits that maturity models provide in terms of the problem of AI implementation are that they allow for internal performance benchmarking, serving as performance enhancement catalysts and serves as community performance improvement catalysts (Caralli, Knight and Montgomery, 2012). Generally, maturity models are categorized into three types: progression models, capability models and hybrid models. The three types of models are summarised in Table 10.

Table 10. Maturity model descriptions (Caralli, Knight and Montgomery, 2012).

Type of maturity model	Description
Progression model	Progression models represent progression of an attribute where the development up the maturity levels indicate progress in the attribute maturity (Caralli, Knight and Montgomery, 2012). These models are measured independently and focus on model attributes instead of attributes that define maturity (Caralli, Knight and Montgomery, 2012).
Capability model	The measured dimension represents the organizations' capability with regards to certain attributes, characteristics and patterns (Caralli, Knight and Montgomery, 2012). This model focuses on the broader organisational capability rather than the ability of performing a simple task (Caralli, Knight and Montgomery, 2012).
Hybrid model	Hybrid models form with the integration of progression model and capability model characteristics. This transitions between levels are similar to the capability model and use the attributes in an architectural progression model way (Caralli, Knight and Montgomery, 2012).

While there are different types of maturity models, but these models mostly conform to certain basic structures (Caralli, Knight and Montgomery, 2012). The importance of this structure is due to the connection it provides between best practices, assessments and objectives. The relationship between current capabilities and improvement roadmaps is facilitated through linking it to business goals, objectives and standards (Caralli, Knight and Montgomery, 2012). The structures/components are (Caralli, Knight and Montgomery, 2012):

- Levels: Representation of transitional states.
- Model domains: For the subject matter of the model. It groups similar attributes into an area of importance.
- Attributes: These are expressed as characteristics, practices, qualities and indicators that are based of observed standards, practices and expert knowledge.
- Appraisal and scoring methods: The scoring methods are algorithms used to ensure that the appraisals are consistent and follow a standard of measurement.
- Improvement roadmaps: Maturity models can be used as guides for improvement efforts.

<u>Capability maturity model</u>

The capability maturity model describes an evolving improvement process ranging from an initial, immature process to a well-defined, mature process. In terms of software development Capability maturity models cover practices for engineering, management of software development and maintenance and planning. The ability of organizations to meet objectives in terms of product quality, cost, scheduling and functionality are improved by these key factors (Kumta and Shah, 2002). The capability maturity model framework can be seen in the figure below.

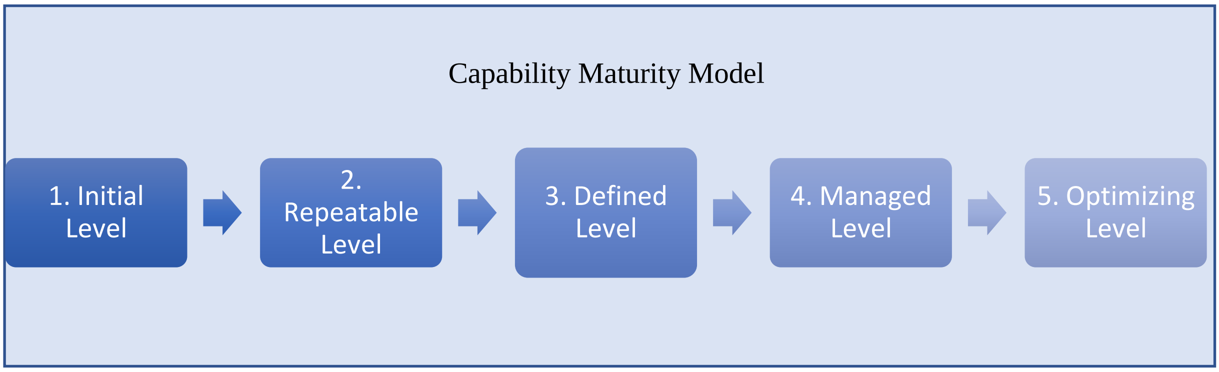

Figure 15. Capability maturity model levels (Kumta and Shah, 2002)

In the table below, the levels of the capability maturity model are further elaborated on with an added focus on software development.

Table 11. Maturity model level descriptions (Kumta and Shah, 2002)

Maturity model level	Description
Initial level	This level indicates that the level of performance of the organization is driven by the competence and skill of the employees (Kumta and Shah, 2002).
Repeatable level	This level focuses primarily on projects. The need in this level is to establish an effective software project management (Kumta and Shah, 2002). These management processes are documented and followed. Top management is only partially involved.
Defined level	This level has an organizational focus, through attaining the best practices across the organization. The establishment of common processes (organization standard software processes) for software management, engineering, measurements and training in this level supports the completion of projects (Kumta and Shah, 2002). The process capability is determined through an organization wide understanding of the roles, responsibilities and activities (Kumta and Shah, 2002).
Managed level	On this level, organisations set quantitative measurable objectives for software processes and products, determining decisions from the data collected and

	quantitatively controlling process performance and project progress (Kumta and Shah, 2002).
Optimizing level	During this level, the main focus is on continuous process improvement. This consists of controlled change and a measurable enhancement in process capabilities (Kumta and Shah, 2002). Examples are reducing the possibility of defects and supporting innovations.

3.4 Artificial Intelligence and industry 4.0 Readiness

Organisations that wish to implement artificial intelligence into their business could possibly be on different readiness/maturity levels when compared to one another. Intel released a White Paper which showed that, through past business experiences, businesses that are acquiring information or implementation on AI can be divided into three groups. These are: organisations that are new to the concept of AI; organizations that are ready to scale up AI; and organizations that are widely implementing AI (Intel, no date a). These scenarios and organizations are further described in the table below.

Table 12. Organization grouping with respective scenarios (Intel, no date a)

Organization group	Common scenarios
Organizations that are new to the concept of AI	Organizations with large existing pools of data.
	Organizations that are executing a workload in a traditional environment.
	Some organizations have been researching AI, but mapping the value-added benefits in advance before implementation is a challenge.
Organizations that are ready to scale up AI.	These can be organizations that have developed a proof of concept for a workstation or device.
	Organizations that have developed their own solution and is looking to implement industry standard software.
Organizations that are widely implementing AI.	Organizations that aiming to expand, due to successfully using AI in a specific stream of business.
	Organizations are successfully learning and interpreting data through AI, but are looking for

	AI solutions that can conduct inference-based activities.

Businesses can be present in various stages of their AI goals and objectives. Continuous success and development to the next stages of their particular AI objectives is dependent on having the correct components established in areas, such as: models and processes; technology and infrastructure; and resources and skills (Intel, no date a). AI readiness is thus divided into three categories: foundational readiness; operational readiness and transformational readiness. Important components of each type of readiness is identified and can be seen in the figure below.

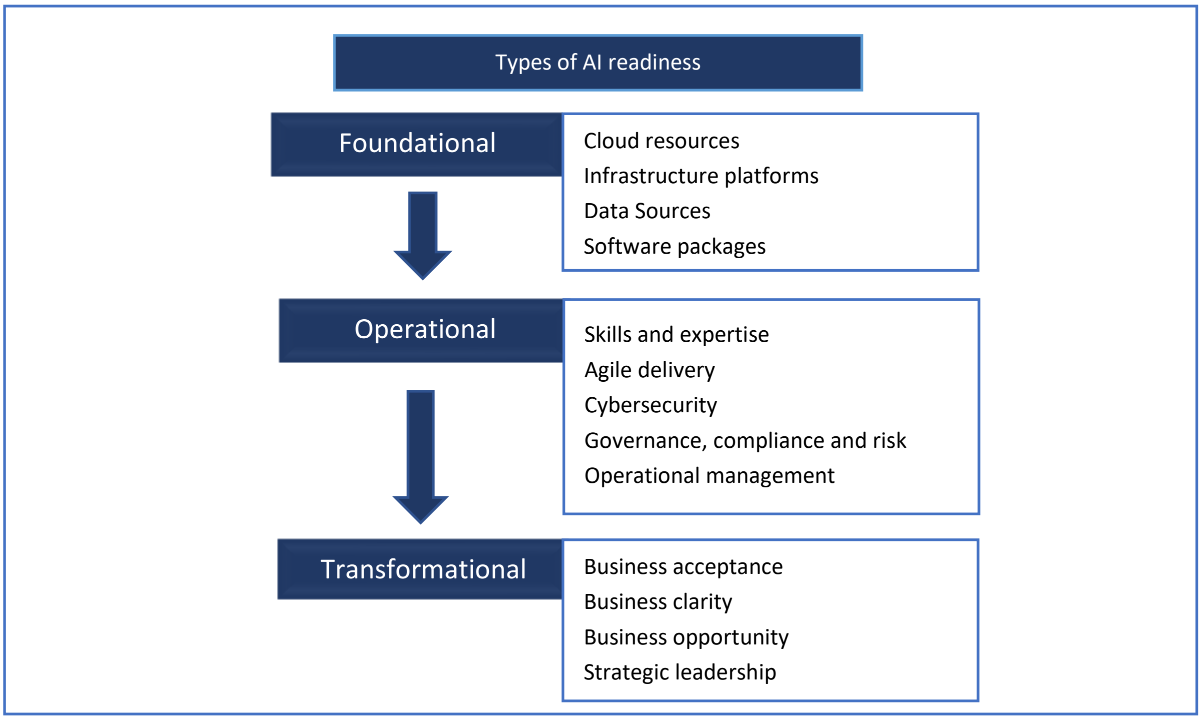

Figure 16. Different types of AI readiness (Intel, no date a)

As AI forms a part of the development and growth of industry 4.0. The study identifies company dimensions used to group maturity items. These, in turn, are used to determine business readiness for industry 4.0 (Schumacher, Erol and Sihn, 2016). This process can be useful when starting to understand what company elements are involved in determining a business' readiness for artificial intelligence. The important generic company dimensions are strategy, leadership, customers, products, operations, culture, people, governance and technology. It can be concluded that the supplemental reviews provided some important insights and data with regards to developing the readiness models. This was the examination of the capability maturity model, generic decision-making methods, AI and industry 4.0 readiness. This is used in combination with the data gathered from the systematized literature review to develop the core of the readiness model. These components will be further identified and categorized at the end of Chapter 4.

Chapter 4 Systematized literature review

Chapter 4 presents the systematized literature reviews conducted for the thesis. The systematized reviews conducted focus on AI readiness, implementation and maturity through the identification of relevant readiness dimensions and elements that are required to determine a business' readiness for AI. A systematic literature review is an important tool used to support evidence-based paradigms from different domains (Budgen and Brereton, 2006). These reviews use carefully developed/defined protocols, which assist in determining which studies are included/excluded, as well as analysing the studies' contributions (Budgen and Brereton, 2006).

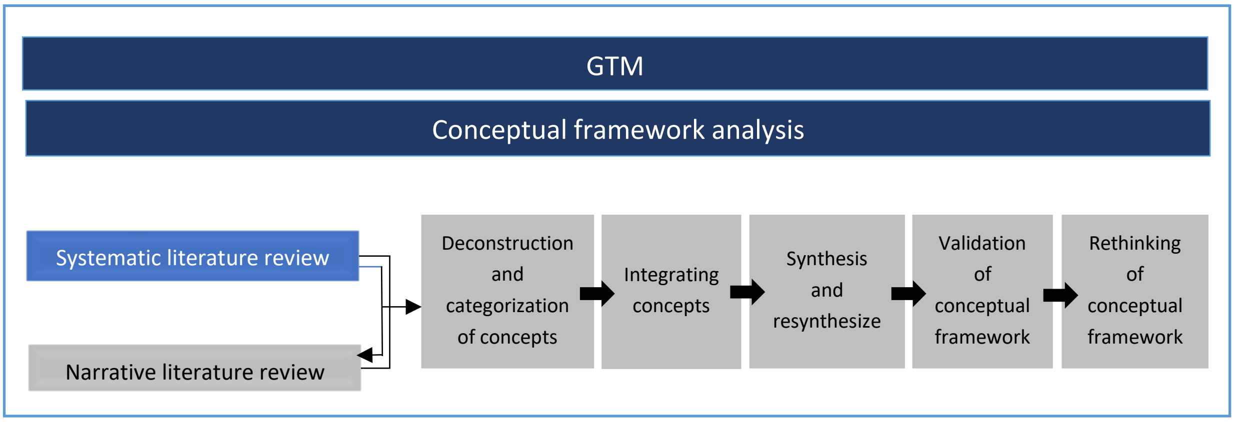

Figure 17. Study methodology steps

Chapter 4 Objectives	Find effective protocols/methodology for conducting a systematized literature review
	Conduct a systematized literature review, which encompasses AI readiness, implementation and maturity
	Synthesize and elaborate on important concepts found regarding artificial intelligence

4.1 Review protocol

In order to conduct the systematized literature reviews, the focus should first shift towards the development of a literature review protocol strategy. This will form the basis and framework for completing the systematized literature reviews. The review protocol designed for this study includes six sequential steps. These steps are: identification of data sources and search terms, development of selection criteria, application of selection criteria, development of study quality assessment procedures, development of extraction strategy and development of dissemination strategy (Keele, 2007), (Okoli and Schabram, 2012). The steps can be seen in Figure 18.

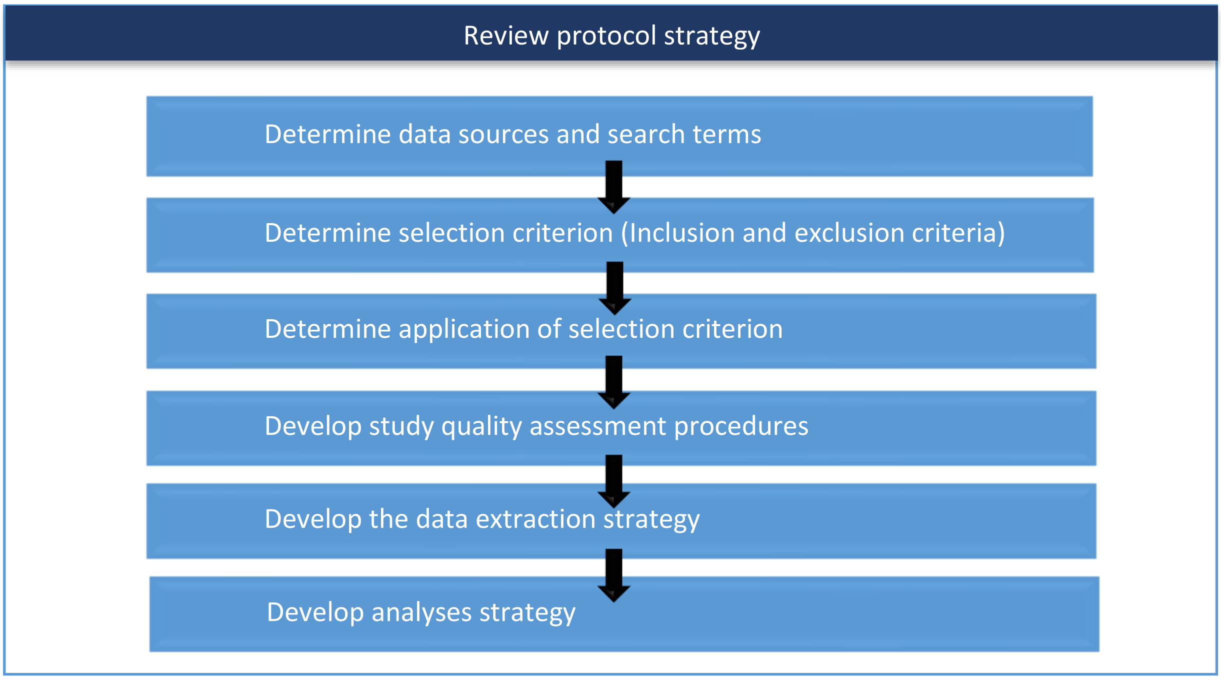

Figure 18. Review protocol strategy (Keele, 2007), (Okoli and Schabram, 2012)

4.2 Maturity implementation model for artificial intelligence

The first systematized literature review focuses on artificial intelligence in combination with maturity/implementation models. The objective was to search through the literature for models, frameworks, as well as business dimensions and elements which assists in determining a business' readiness for the facilitation, integration or planning of AI into the business. The strategy for this systematized literature search followed the protocol developed in Figure 18.

Search terms

The data base, Scopus was used for the literature search. Scopus is large citation and abstract database consisting of peer-reviewed literature, which consists of conference papers, books and journals (Scopus, 2018). The Scopus database was searched using the search terms shown Table 13. The primary studies were iterated by adding additional terms in the database search. The search was filtered to search for abstracts, titles and keywords. The results can be seen below.

Table 13. Database search results

Scopus database search (conducted on 05/06/2018)	
Search terms	**Number of studies found**
Artificial	1 010 882
Artificial AND Intelligence	288 409
Artificial AND Intelligence AND Maturity	351

Artificial AND Intelligence AND Maturity AND Implementation	55
Artificial AND Intelligence AND Maturity AND Implementation AND Model	35

As Table 13 illustrates, the search term iteration reduced the number of primary studies to 35 studies. The author names, paper title, publication year, affiliations, abstract and methodology were retrieved from these primary documents. These documents were then assessed against the developed selection criteria to assist in improving the quality of the outcomes, as well as reducing any bias or repetition. The CAT1 and CAT2 selection criteria, as seen in Table 14, were applied while the documents' data was being obtained due to the application of these criterion is simple in nature.

Application of selection criteria

The selection criteria that had been developed focused on availability, language, types of literature, applicability of literature and academic robustness of the literature. Descriptions of the criteria can be seen in Table 14 below. The papers that the search term iterations found were scrutinised and important information was extracted from them. The information consists of author names, abstracts, paper titles, publication years, affiliations and types of documents. The information gathered was then exported to excel where it is assessed in terms of the selection criteria in the sequence of validation, which is CAT1, CAT2, CAT3, CAT4 AND CAT5. This can be seen in Appendix L.

Table 14. Selection criteria

Reference of criteria	Criteria	Description of criteria
CAT1	Availability	The full document must be freely available online.
CAT2	Language	English literature only.
CAT3	Types of literature	Conference reviews, lecture notes and lecture presentations are excluded.
CAT4	Applicability of literature	Ensure that the literature has relevant input towards the proposed study from evaluating the abstract.
CAT5	Academic robustness of the paper	The literature is evaluated in terms of validity of the

		methodology used, number of citations, use cases, interviews and length of the paper.

To be included, a study had to pass all the selection criteria. After the primary studies had been validated against the selection criteria, ten studies remained. Their studies' titles are:

- Digitalization Canvas – Towards identifying digitalization use cases and projects
- Neural networks: An overview of early research, current frameworks and new challenges
- An enterprise risk management knowledge-based decision support system for construction firms
- Determination of Rule Patterns in Complex Event Processing Using Machine Learning Techniques
- A guide to implement open data in public agencies
- Research on quality measuring of CMMI cyclic implementation in software process
- Managing quality in outsourcing of high-end services: A conceptual model
- A model to assess open government data in public agencies
- Computer-aided warehouse engineering (CAWE): Leveraging MDA and ADM for the development of data warehouses
- A development process of KMS based on systems engineering methodology

These studies are further examined in the quality assessment section following to ensure that they are viable, robust and provide insightful information with regards to the proposed study.

Quality Assessment

The quality criterion developed consists of methodology, aim/goals and completeness of document. The descriptions of these criterion can be seen in the table below.

Table 15. Quality Assessment criteria

Quality assessment categories	Description
Completeness of document	Sufficient sections are included in the study, such as abstract, methodology and validation of research.
Methodology	Robust/satisfactory methodology which should be appropriate for the stated research question.
Aim/Goals	Clear and thorough statement of the research.

The quality of the ten studies was assessed against the criteria. All the studies passed the selection criteria, as seen in Appendix M. During this quality assessment phase, it became apparent that two studies with different titles have the exact same content, the two studies are entitled “A model to assess open government data in public agencies” and “a guide to implement open data in public agencies”. One of these studies was removed.

Extraction and analyses of the data

The following sections will provide some information on the literature that was found and that passed the selection process. The purpose is to better understand the data which was gathered and its context. The data extraction strategy was designed to collect all the information required to address the research review questions and quality criteria (Keele, 2007), (Okoli and Schabram, 2012). The papers are individually read and the information with regards to the research questions and quality criteria extracted.

Initially a descriptive analysis was done on the studies that passed the inclusion criteria, as well as the quality assessment. The number of citations for each of the papers obtained is shown in the figure below. From a researchers’ stand point, this analysis is valuable in terms of determining, which were highly cited papers and from there determine the relevant authors. The knowledge of these authors could provide researchers in the future with a more immediate way to identify relevant topics from highly regarded authors and researchers

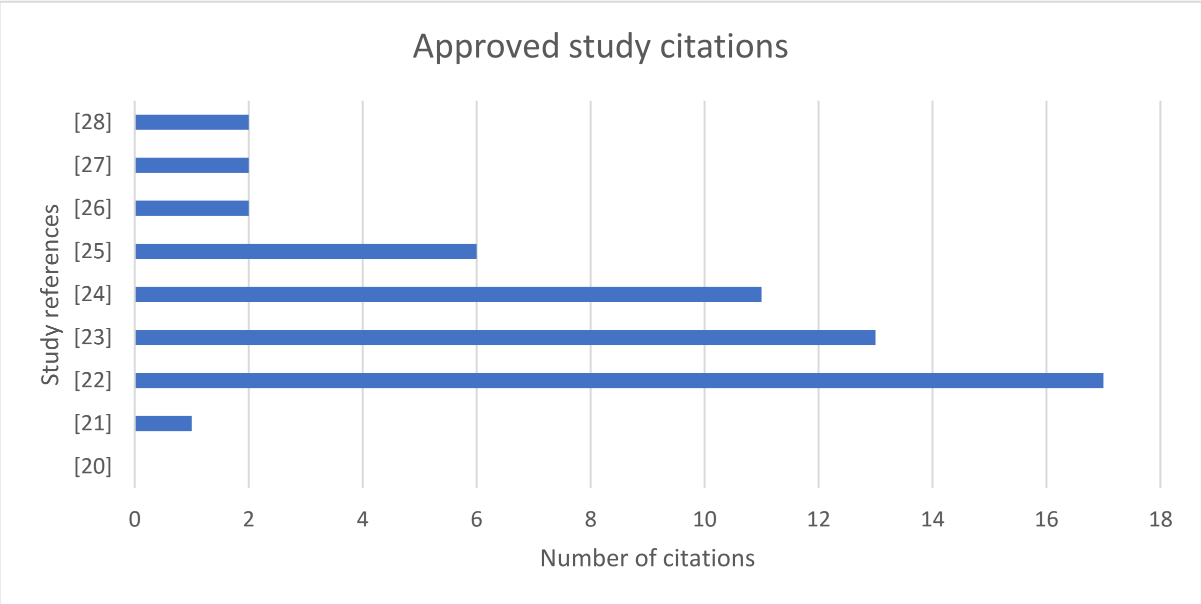

Figure 19. Number of citations

The publication years of the selected studies can be seen in the table below. This provides some insights into how recent these chosen studies are. Because they are recent, the studies could still provide applicable literature with regards to the study.

Table 16. Publications year of studies

Approved Studies	Publication Date
Digitalization Canvas – Towards identifying digitalization use cases and projects (Heberle *et al.*, 2017)	2017
Neural networks: An overview of early research, current frameworks and new challenges (Prieto *et al.*, 2016)	2016
An enterprise risk management knowledge-based decision support system for construction firms (Zhao, Hwang and Low, 2016)	2016
Determination of Rule Patterns in Complex Event Processing Using Machine Learning Techniques (Mehdiyev *et al.*, 2015)	2015
Research on quality measuring of CMMI cyclic implementation in software process (Zhou and Li, 2012)	2012
Managing quality in outsourcing of high-end services: A conceptual model (Srivastava, Sharfuddin and Datta, 2012)	2012
A model to assess open government data in public agencies (Solar, Meijueiro and Daniels, 2017)	2012
Computer-aided warehouse engineering (CAWE): Leveraging MDA and ADM for the development of data warehouses (Kurze and Gluchowski, 2010)	2010
A development process of KMS based on systems engineering methodology (Xu, 2009)	2009

Analysis of chosen studies

The analysis of the chosen studies, encompasses defining categories or themes with regards to maturity, model development and AI implementation from the chosen studies.

Approved Study 1

Digitization is the process of transitioning from analogue to digital forms. Digitalization involves using digital technologies to improve value-adding opportunities and business models (Heberle *et al.*, 2017). Digitization is a prerequisite for successful digitalization towards implementing software business processes (Heberle *et al.*, 2017). AI technologies and digitalization projects require drivers such as data collection and data usage in the business, as well as resources, budgets and support from management (Heberle *et al.*, 2017). There are two approaches towards digitalization: top down and bottom up (Heberle *et al.*, 2017). These approaches raise the following questions:

- Top down (Heberle *et al.*, 2017): How does digitalization change the business model? What are the benefits of digitalization for the business?
- Bottom up (Heberle *et al.*, 2017): How can digitalization optimize current business processes? Which data sources are available? Which data analytics are required?

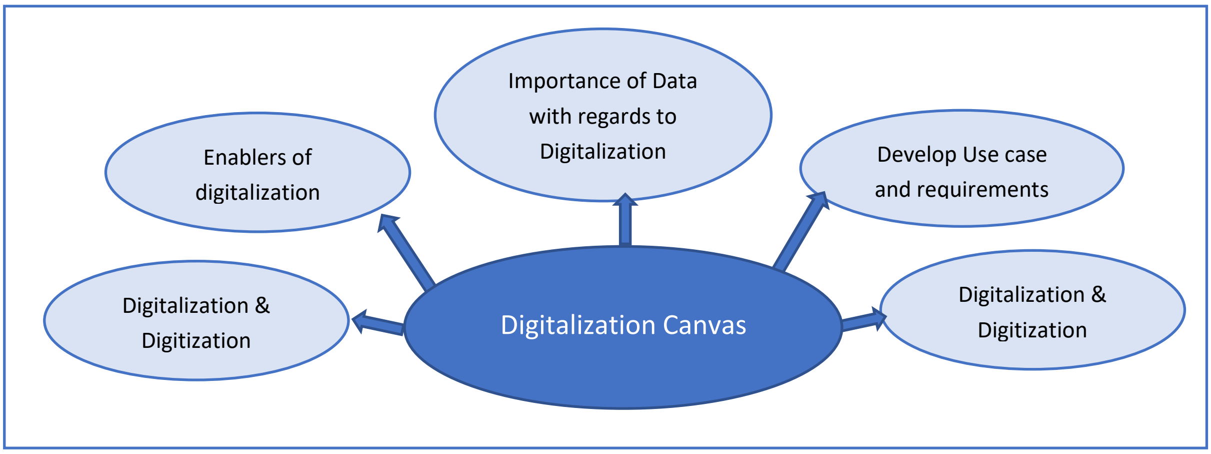

Figure 20. Themes and categories within Digitization Canvas (Heberle *et al.*, 2017)

From the information gathered, it is evident that AI forms part of business' digital transition/transformation: i.e. digitization and digitalization. The main information that is extracted, is possible business elements that are vital to facilitate digitization/digitalization, that can be applied to AI as well. These elements are data collection, data usage, digitalization resources, budgets and executive support.

Approved Study 2

In summary, the main points derived from the literature are: defining the advantages and outputs of capability maturity models, high level description of capability maturity levels and operations. Capability maturity model integration describes discrete levels of process improvement which can be applied towards processes and organizations (Zhou and Li, 2012). The capability maturity model integration presented in the systematized literature review has five maturity levels and twenty-two key process areas. The five maturity levels are initial, managed, defined, quantitatively managed and optimizing (Zhou and Li, 2012). The maturity levels advance in ascending order. For example, if a business wants to achieve a level 3 CMMI, then all the key processes in level 2, as well level 3 must be satisfied (Zhou and Li, 2012). This study provides a maturity model (capability maturity model integration) that focuses on quality improvements. There must thus be further studies conducted on the different application of maturity models, with the aim of integrating the literature into an effective maturity model, which assists in AI implementation.

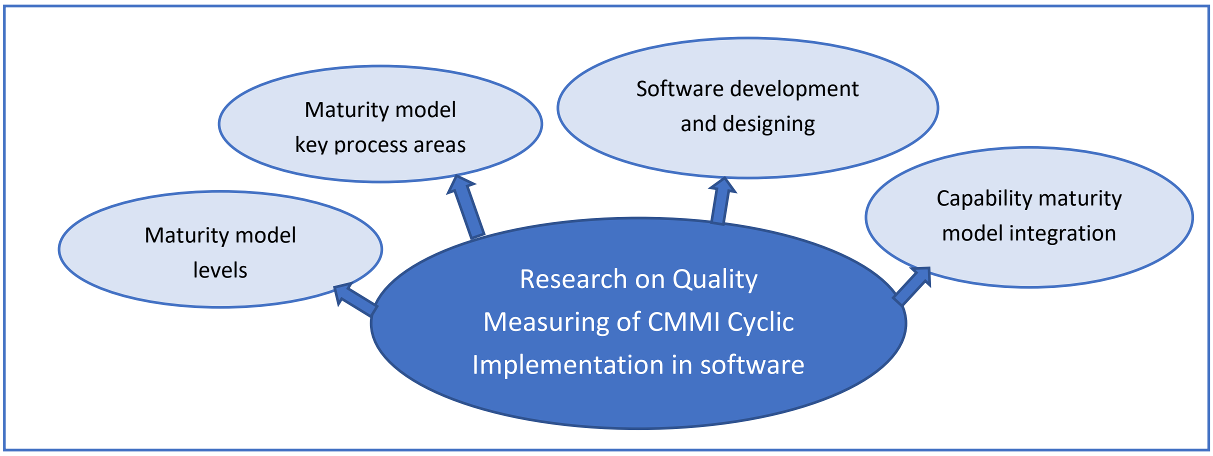

Figure 21. Themes and categories within Research on Quality Measuring of CMMI Cyclic Implementation in software (Zhou and Li, 2012)

The following studies (approved studies 3-9) passed the selection criteria and quality assessment. However, these studies did not produce relevant data with regards to this study or to the development of the readiness models. The themes and categorisation of these papers are shown in the Figures below.

Approved Study 3

In this study (Prieto *et al.*, 2016), the neural networks study provided in-depth insights into neural networks – a method of AI and the application thereof. The theme of data was also highlighted in the study; however, the study was not high level enough in terms of business requirements, operations or management thereof. The themes can be seen in the figure below.

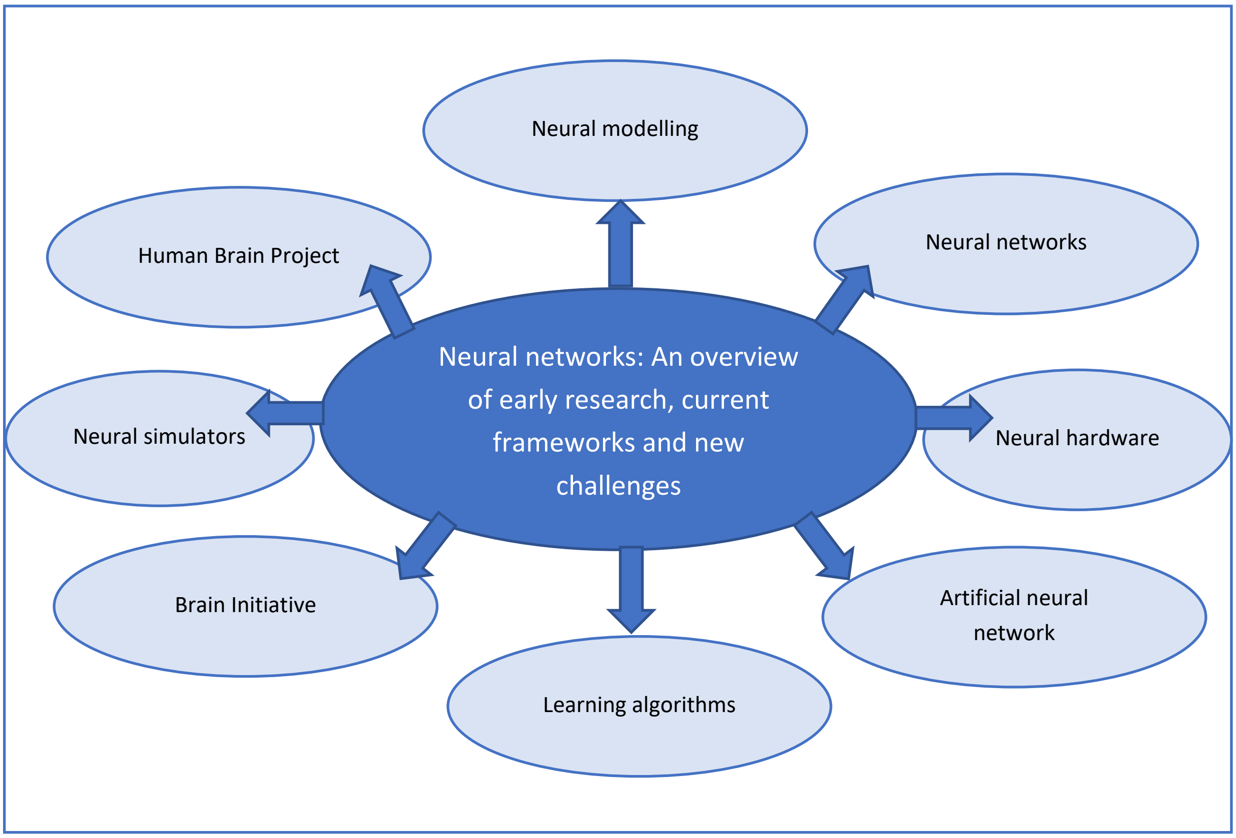

Figure 22. Themes and categories within Neural networks: An overview of early research, current frameworks and new challenges (Prieto *et al.*, 2016)

Approved Study 4

In study 4 (Solar, Meijueiro and Daniels, 2017), The maturity model was developed to asses open government data in public agencies focused on the development of a maturity model called open data maturity model. This assesses the commitment and capabilities of public agencies with regards to practices of open data (Solar, Meijueiro and Daniels, 2017). The maturity model is comprised of three hierarchical structures namely, domains, sub-domains and critical variables. Within the 33 critical variables identified, four capacity levels exist, which is overall distributed in nine sub-domains to determine the business' maturity (Solar, Meijueiro and Daniels, 2017). This study does not focus on AI or AI related requirements, operations or management that could be added into the proposed readiness model.

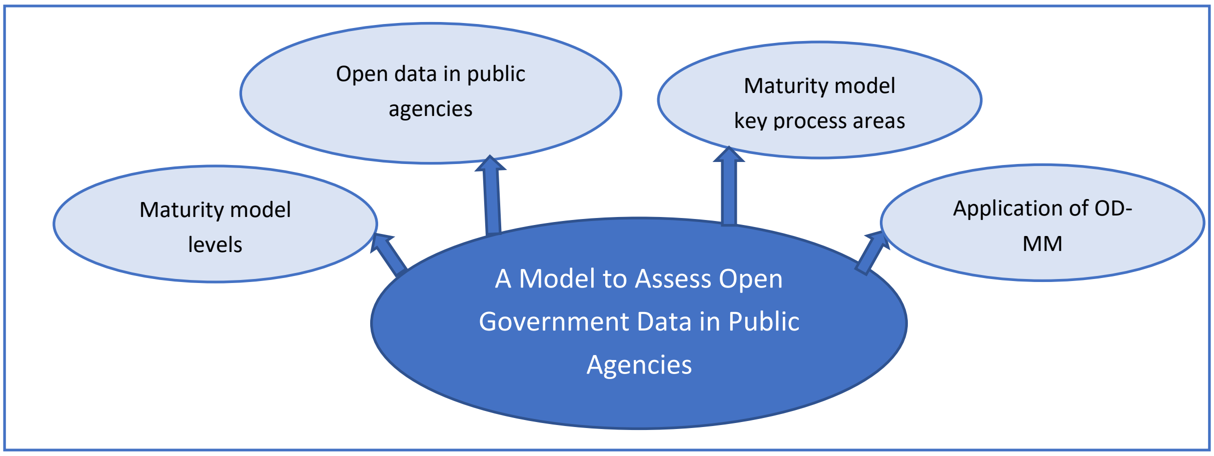

Figure 23. Themes and categories within**:** A Model to Assess Open Government Data in Public Agencies (Solar, Meijueiro and Daniels, 2017).

Approved Study 5

The fifth study (Mehdiyev *et al.*, 2015) was concerned with the determination of rule patterns in complex event processing that use machine learning techniques. The study focused more towards the integration of rule-based machine learning approaches to complex event processing systems, due to that possibly no prior research has adopted rule-based classifiers to automate the derivation of rule patterns (Mehdiyev *et al.*, 2015). The themes can be seen in the figure below. For the purposes of this study, Study 5 was not at a high enough level in terms of business requirements, operations or management of AI in business.

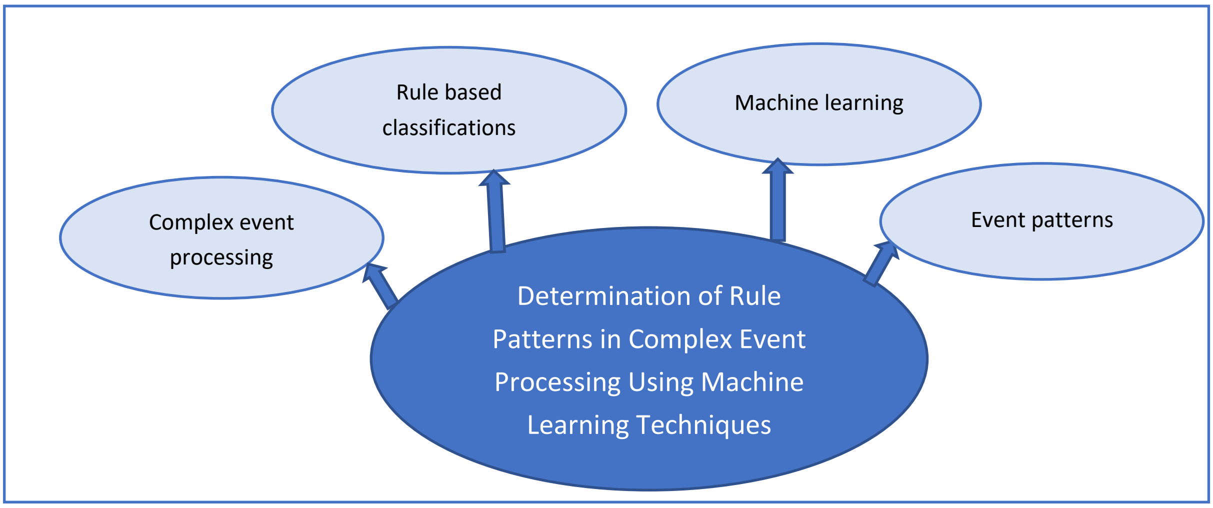

Figure 24. Themes and categories within**:** Determination of Rule Patterns in Complex Event Processing Using Machine Learning Techniques (Mehdiyev *et al.*, 2015)

Approved Study 6

Study 6 (Kurze and Gluchowski, 2010) covered: the Computer-Aided Warehouse Engineering (CAWE): Leveraging Model Driven Architecture (MDA) and Architecture Driven Modernization (ADM) for the Development of Data Warehouses. The study showcased both previously established and future research directions regarding concepts of model-driven architecture and architecture driven modernization from software engineering disciplines to data warehousing disciplines (Kurze and Gluchowski, 2010). For the purposes of this study, study 6 did not focus at all with regards to high level business requirements, operations or management of AI or AI-related themes in the business. The study was also solely focused on the warehousing aspect, thus there was no generic themes to be used in this study. The themes can be seen in the figure below.

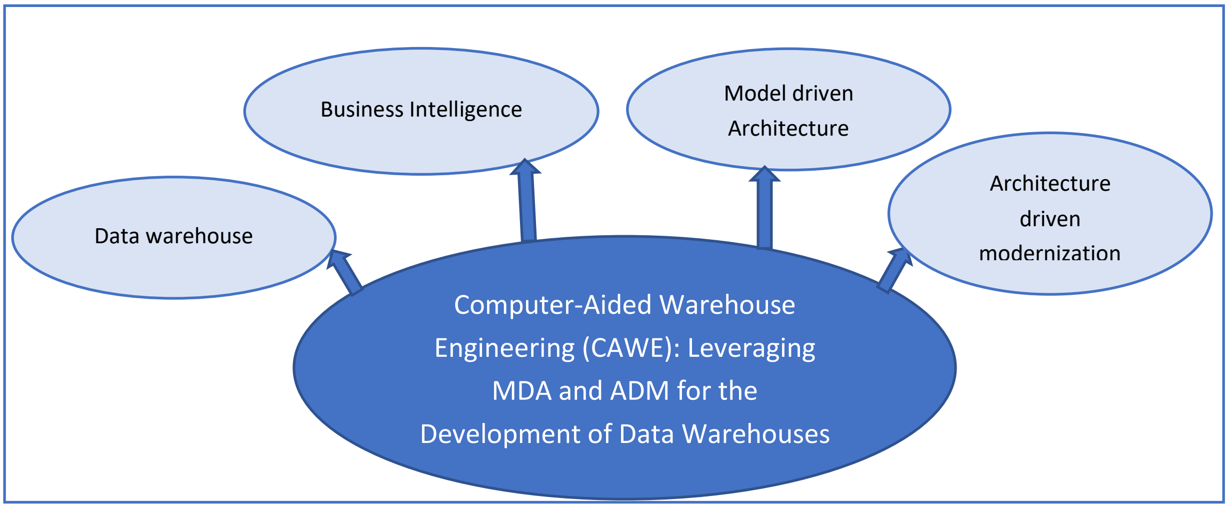

Figure 25. Themes and categories within**:** Computer-Aided Warehouse Engineering (CAWE): Leveraging MDA and ADM for the Development of Data Warehouses (Kurze and Gluchowski, 2010)

Approved Study 7

Study 7 (Zhao, Hwang and Low, 2016), focused on developing a knowledge-based decision support system for enterprise risk management to facilitate the ERM implementation for Chinese construction firms. This system has four objectives: assess the ERM maturity in a Chinese construction firms, visualize the ERM maturity assessment results, provide plans of action for improvement of ERM implementation according to the maturity continuum and finally develop a printable ERM maturity assessment report (Zhao, Hwang and Low, 2016). For the purposes of this study, study 7 did not focus on high level business requirements, operations or management of AI or AI-related themes in the business. The study is also focused towards Chinese construction firms, thus in terms of generic elements the study's contents could not be used. The themes can be seen in the figure below.

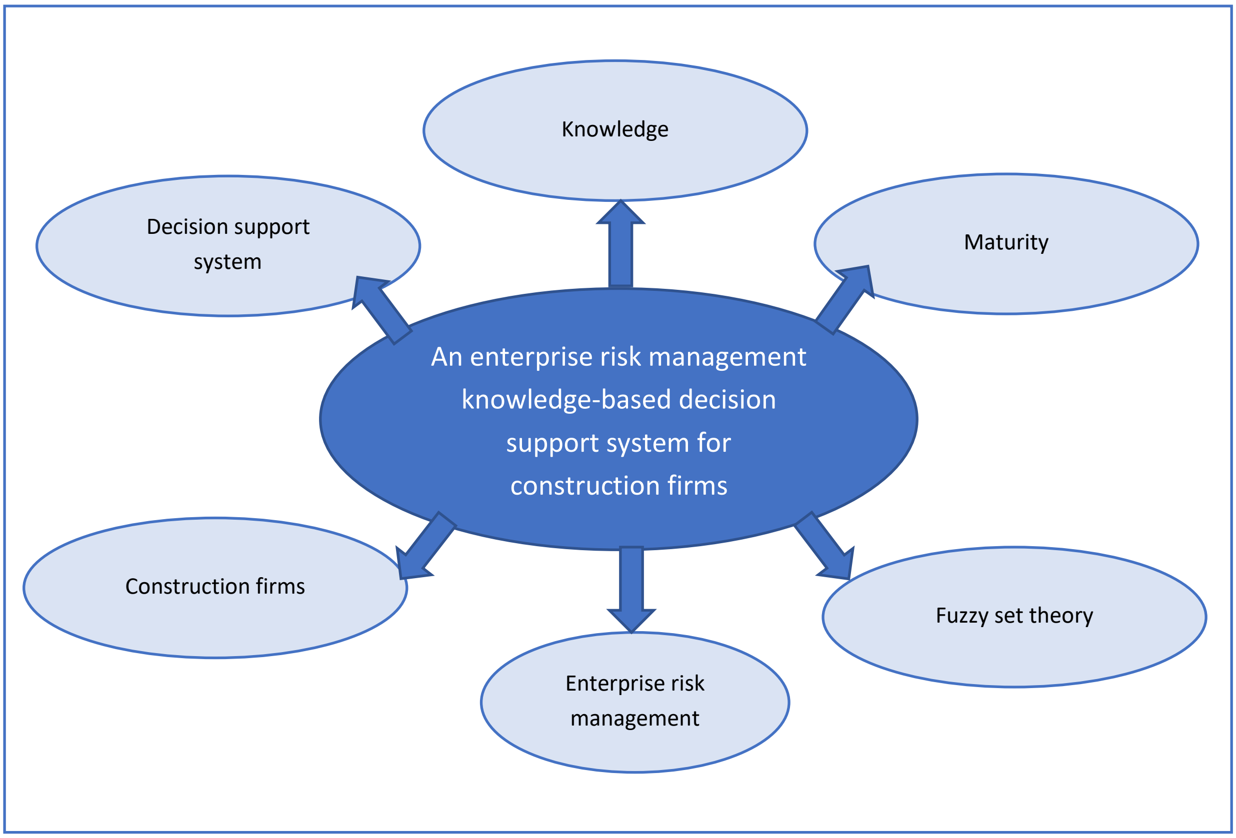

Figure 26. Themes and categories within**:** An enterprise risk management knowledge-based decision support system for construction firms (Zhao, Hwang and Low, 2016)

Approved Study 8

Study 8 (Srivastava, Sharfuddin and Datta, 2012), focused on presenting a unique combination of the SERVQUAL model and e-sourcing capability maturity framework, which explores the antecedents of service gaps (Srivastava, Sharfuddin and Datta, 2012). The study is comprised of a qualitative study, which incorporates data collected from senior managers from various Indian service providers through semi-structured questionnaires and interviews (Srivastava, Sharfuddin and Datta, 2012). It further addresses the issues of continuous improvement by utilising knowledge inherent in non-numeric data generated by service delivery. For the purposes of this study, the selected study was not focused on high level business requirements, operations or management of AI or AI-related themes in the business. The themes can be seen in the figure below.

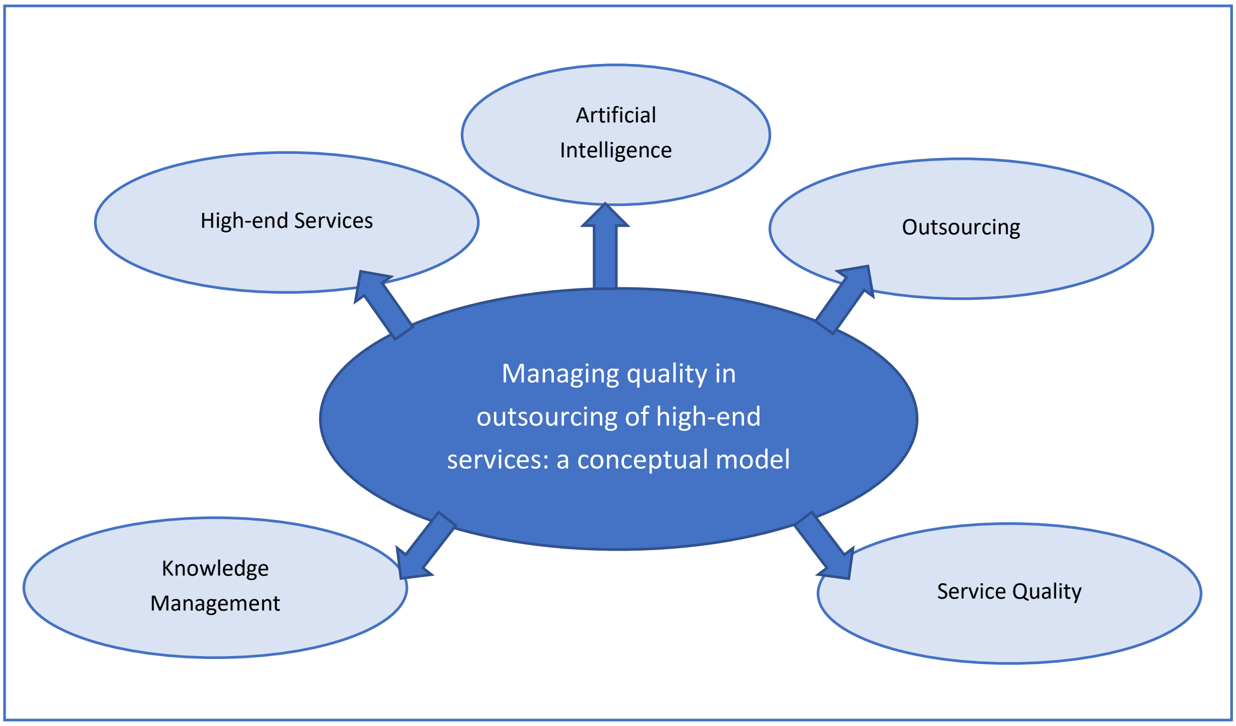

Figure 27. Themes and categories within**:** Managing quality in outsourcing of high-end services: a conceptual model (Srivastava, Sharfuddin and Datta, 2012)

Approved Study 9

Study (Xu, 2009), focused on analysing a methodological framework on knowledge systems engineering to guide the implementation of knowledge management project, as well as the establishment of a developmental process of knowledge management system. This includes eight key steps based on a methodological framework, as well as a detailed analysis for each key step (Xu, 2009). For the purposes of this study, the selected study did not focus on high level business requirements, operations or management of AI or AI-related themes in the business. The themes can be seen in the figure below.

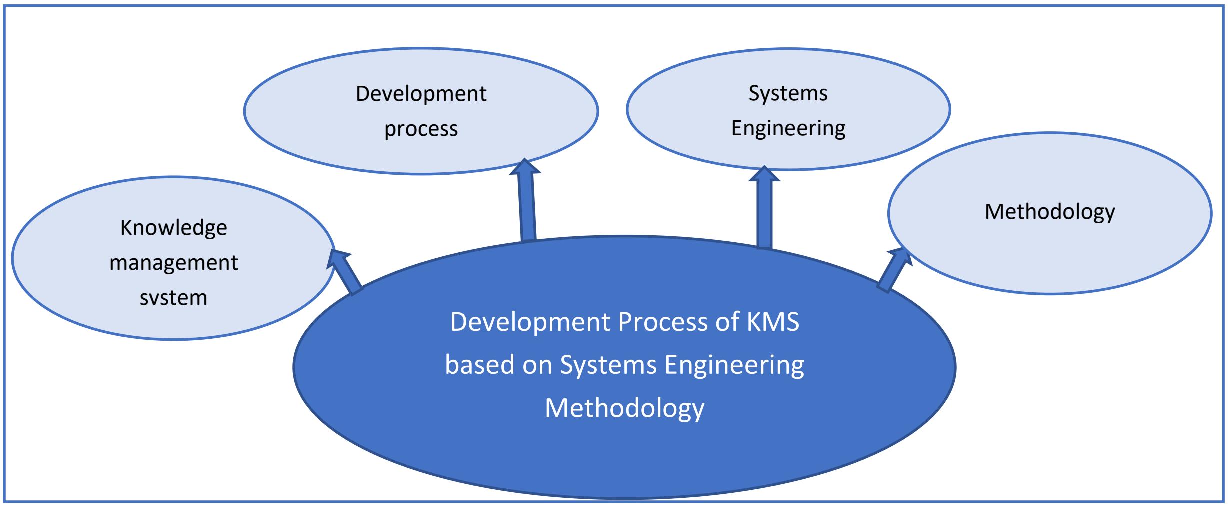

Figure 28. Themes and categories within: A Development Process of KMS based on Systems Engineering Methodology

In concluding the systematized literature review, it is evident that there is a lack of academic material regarding frameworks or models that focus on implementation, integration, operation and management of AI in businesses of all sizes. The work identified that could potential form part of the aimed readiness model, is derivative of data gathered through AI-related literature. After these studies have been thoroughly read, it was concluded that two studies had content that would assist in the development of a readiness or maturity model regarding AI. It was decided that a secondary systematized literature review had to be conducted, focusing more on artificial intelligence readiness in the business. This is discussed in the following sections. The mapping of relevant content will be highlighted at the end of this chapter.

4.3 Combination of industry 4.0 and AI readiness

In this section, the literature focuses on industry 4.0 readiness, identified in the first systematic literature review, as well as AI readiness. As Artificial intelligence forms part of the digital transformation of businesses within industry 4.0, a combination of the two themes, (AI readiness and industry 4.0 readiness) has been integrated. The aim is to identify and compare the readiness dimensions and elements found in academic sources and business sources. The readiness dimensions for determining maturity and readiness have been identified, as have the readiness elements found within some readiness dimensions. This information was obtained through a combination of academic and business literature. The results can be seen in the tables below.

Table 17. Identification of readiness dimensions

Readiness dimensions from academic sources (Schumacher, Erol and Sihn, 2016)**,** (Heberle *et al.*, 2017)	**Readiness dimensions from business sources** (Faktion, 2019)**,** (Intel, no date b)
Strategy	Strategy
Leadership	Operations
Customers	People
Products	Governance
Operations	Operations
Culture	Data
People	Resources
Governance	Security
Technology	Legal
Data	
Resources	

Table 18. Combination of academic and business readiness dimensions and elements

Combined dimensions	**Readiness elements** (Sharma, Kaulgud and Duraisamy, 2016)**,** (Heberle *et al.*, 2017)**,** (Faktion, 2019)**,** (Intel, no date b)
Strategy	Business case clarity
Leadership	Strategic leadership
	Business opportunity
Customers	/
Products	/
Operations	Operational mangement
	Agile delivery
Culture	Business acceptance
People	Skills and expertise
Governance	/
Technology	Infrastructure platform
Data	Data sources
Resources	Cloud resources

Security	Cyber security
Legal	/

4.4 AI readiness model systematized literature review

The focus of this systematized literature review is to identify readiness models related to Artificial Intelligence and new technology readiness. These form an important part of the literature used in this study and provide a foundation with regards to development of a readiness model by identifying readiness dimensions and possible elements. The systematized literature review protocol developed in Figure 18 was be used in this review.

Search terms

The search terms in the table below was used in the Scopus database. The primary studies were iterated by adding additional terms in the database search. The data base search was filtered to search for abstracts, titles and keywords. The results can be seen below.

Table 19. Database search results

Scopus database search (conducted on 18/12/2018)	
Search terms	**Number of studies found**
Artificial AND Intelligence AND Readiness AND model	50

The author names, paper title, publication year, affiliations, abstract and methodology were retrieved from these primary documents. These documents were assessed against the developed selection cirteria to assist in improving the quality of the outcomes, as well as reducing any bias or repetitive work. The CAT1 and CAT2 selection criteria as seen in Table 14 was applied while the documents' data was being obtained due to the application of these criterion was simple in nature.

Application of selection criteria

The selection crietria developed focused on availability, language, types of literature, applicability of literature and academic robustness of the literature. Descriptions of the criteria can be seen in Table 14. The papers that the iterative searches produced were carefully read and important information was extracted from these studies. The information consisted of author names, abstracts, paper titles, publication years, affiliations and types of documents. The information gathered was exported to excel to be assessed in terms of the selection criteria in the sequence of validation;i.e. CAT1, CAT2, CAT3, CAT4 AND CAT5. This can be seen in Appendix J.

After the primary studies were validated against the selection criteria, 5 studies remained. These studies were validated according to the developed quality assessment. The list of approved studies were:

- Employee readiness for acceptance of decision support systems as a new technology in E-business environments; A proposed research agenda
- The ML test score: A rubric for ML production readiness and technical debt reduction
- Cloud readiness assessment framework and recommendation system
- A fuzzy logic based green information technology readiness model
- Technology Readiness Model for Enterprises

These studies were examined in the quality assessment section. This was to ensure that the studies identified were viable, robust and provide insightful information with regards to the proposed study.

<u>Quality Assessment</u>

The quality assessment criteria can be seen in Table 15. The quality references can be seen as methodology, goals and completeness of document. The quality of the five studies was assessed against these selection criteria and all the studies passed. The results can be seen in Appendix K.

<u>Analysis and categorization of the data</u>

The following discussion identifies the characteristics, categories, readiness dimensions and readiness elements with regards to AI or technology related literature. Thirteen high level characteristics were found to characterize the results of this systematized literature review. These characteristics are technological readiness dimensions, enterprise focus, environmental focus, multi-criteria analysis, fuzzy logic, Green IT, cloud computing/services, machine learning effectiveness focus, rubric assessments, machine learning, hybrid models, employee focused and readiness models. This information is illustrated in Figure 29.

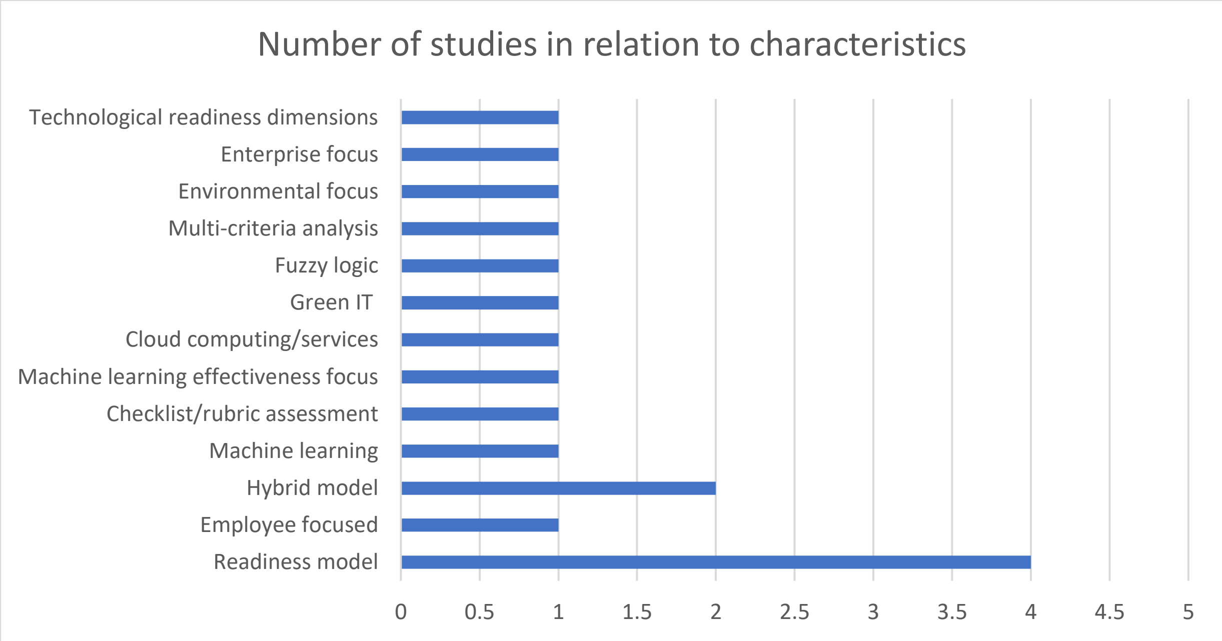

Figure 29. Characteristics of studies

The publication years of the chosen studies can be seen in the figure below. This provides some insights into how recent these chosen studies are.

Table 20. Publication years of chosen readiness studies

Approved Studies	Publication Date
Employee readiness for acceptance of decision support systems as a new technology in E-business environments; A proposed research agenda (Ahmed, Qin and Aduamoah, 2018)	2018
The ML test score: A rubric for ML production readiness and technical debt reduction (Breck *et al.*, 2018)	2018
Cloud readiness assessment framework and recommendation system (Alemeye and Getahun, 2015)	2015
A fuzzy logic based green information technology readiness model (Deng, Molla and Corbitt, 2009)	2009
Technology Readiness Model for Enterprises (Oztemel and Polat, 2006)	2006

Analysis of chosen studies

The next step in the analysis of the studies was defining/developing categories or themes for the data found in each of these studies. The studies will be discussed below and the characteristics of the study will be graphically depicted.

Approved Study 1

Entitled "Employee Readiness for Acceptance of Decision Support Systems as a New Technology in E-Business Environments; A Proposed Research Agenda", this study (Ahmed, Qin and Aduamoah, 2018) focuses on the development of a methodology for the application of a conceptual model. The aim is to investigate the effects of employee readiness on technology acceptance with regards to new technologies and E-businesses (Ahmed, Qin and Aduamoah, 2018). The proposed model combines the employee readiness for E-business (EREB) model and the technology acceptance model (TAM). Employee readiness with regards to new technology could prove very useful in the development of the aimed readiness model, due to that it provides another perspective on a business' readiness: the employees and culture. The readiness elements could be incorporated into the developed readiness model. Theses readiness elements are security, benefits, certainty, collaboration, perceived ease of use and perceived usefulness. The themes can be seen in the figure below.

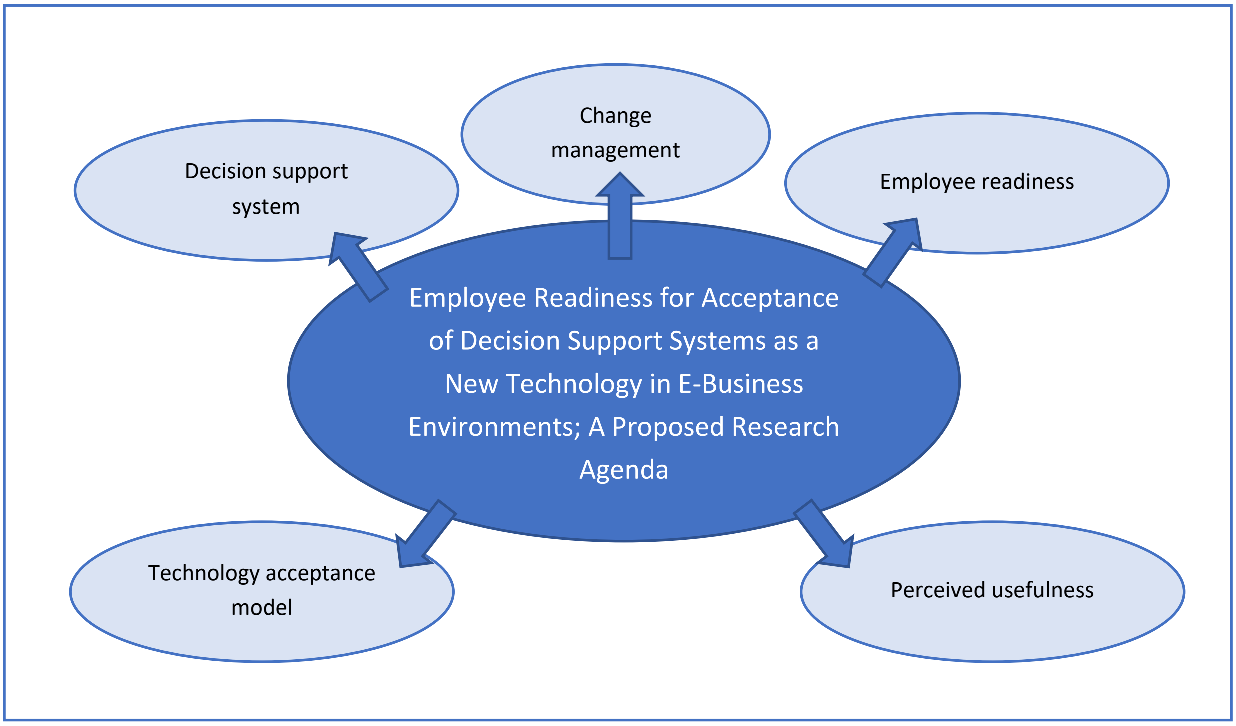

Figure 30. Themes and categories within: Employee Readiness for Acceptance of Decision Support Systems as a New Technology in E-Business Environments; A Proposed Research Agenda

The construction of measuring employee readiness for E-business, through the employee readiness for E-businesses (EREB) model is divided into 4 dimensions: security, benefits, collaboration and certainty (Ahmed, Qin and Aduamoah, 2018). The descriptions of these dimensions/elements can be seen in the table below.

Table 21. Employee readiness dimensions (Ahmed, Qin and Aduamoah, 2018)

Dimension	Description
Security	This focuses the job security of the employee, as well as state of mind with regards to the possibility of job changes, job losses and power/influence shifts (Ahmed, Qin and Aduamoah, 2018).
Benefits	This refers to the perceived belief of the employee with regards to the improvements they will receive in terms of productivity and efficiency increases (Ahmed, Qin and Aduamoah, 2018).
Collaboration	This refers to the willingness of employees to interact, cooperate and share information with each other through digital technologies (Ahmed, Qin and Aduamoah, 2018).
Certainty	Refers to the employees' clear understanding, cooperation and believe in the functions and application of e-business (Ahmed, Qin and Aduamoah, 2018).

With regards to the employee readiness, the technology acceptance model (TAM) provides two readiness elements namely, perceived usefulness and ease of use. TAM is shown to be one the most vigorous and capable models for the prediction of user acceptance (Alemeye and Getahun, 2015). Perceived usefulness – This is characterized by the subjective probability that an individuals' use of a specific application framework will develop their capacity towards occupational productivity (Ahmed, Qin and Aduamoah, 2018), (Alemeye and Getahun, 2015). Perceived ease of use – This is characterized by the anticipation of effort involved in the new technology framework (Ahmed, Qin and Aduamoah, 2018), (Alemeye and Getahun, 2015).

Approved Study 2

Study 2 (Alemeye and Getahun, 2015), "Cloud Readiness Assessment Framework and Recommendation System", focuses on developing a cloud readiness assessment framework and an expert system to assess cloud readiness. The study also recommends cloud deployment and services models to adopt. This research study is grounded with innovation adoption theories such as technology organization environment framework (TOE), diffusion of innovation (DOI) and technology acceptance model (TAM). These provided many generic readiness elements and dimension that are of value with regards to developing the AI readiness model. The TAM model was already described above and the readiness elements have also already been extracted. The DOI theory identifies five dimensions or elements that determine the adoption of new technologies. These are: relative advantage, compatibility with existing values and practices, ease of use, trial-ability and observable results (Alemeye and Getahun, 2015). The technology organization environment framework (TOE) identified three contexts, each with their own elements. The three contexts are organisational context, technological context and environmental context (Alemeye and Getahun, 2015). The elements that are incorporated in each of the main contexts can be seen below.

Table 22. Technology organization environment frameworks' main contexts (Alemeye and Getahun, 2015)

Main contexts	Elements
Organisational context	Executive support
	budget
	business cases
Technological context	Technological readiness
	Network connectivity
Environmental context	Competitive pressure

The characteristics and themes that have been identified in this document are illustrated in the figure below.

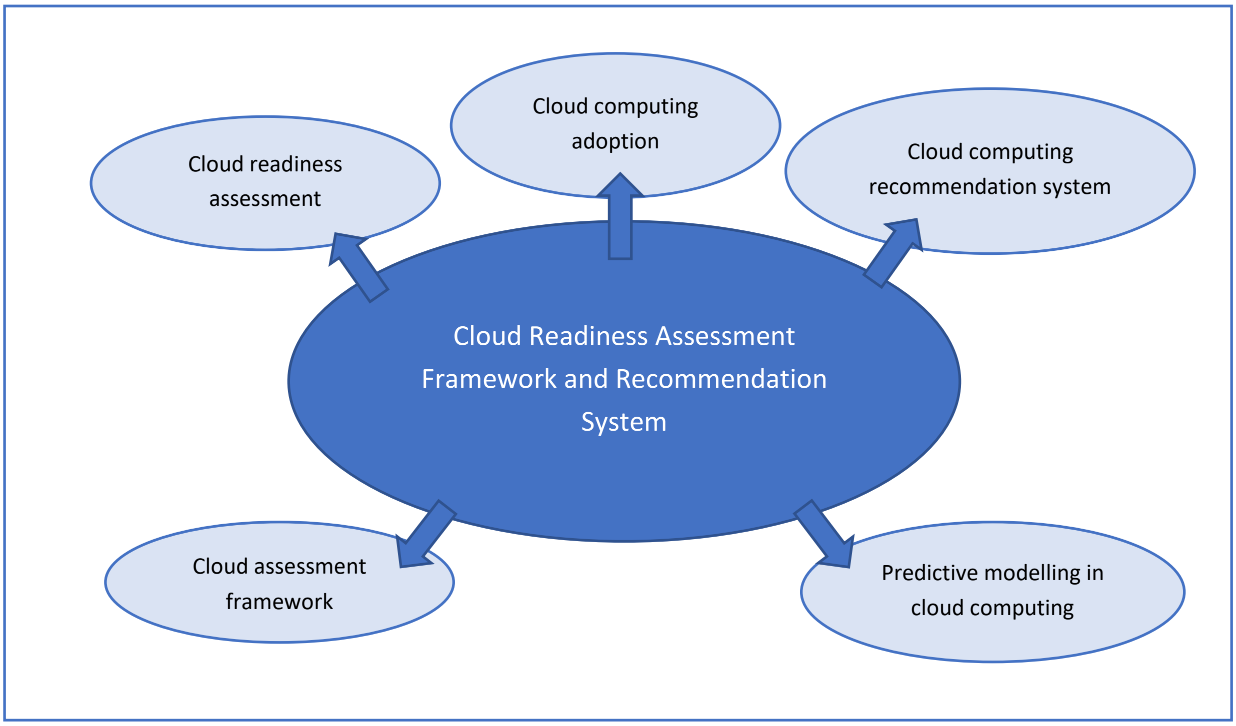

Figure 31. Themes and categories within: Cloud Readiness Assessment Framework and Recommendation System

Approved Study 3

In study 3 (Oztemel and Polat, 2006), "Technology readiness model for enterprises", the study focuses on presenting an innovative technology management model specifically for enterprises. This model provides an overview of existing technology assessment models and introduces the developed technology readiness model. Consequently, the readiness elements and components are generic and all are considered for integration within the proposed AI readiness model. The focus of the technology readiness model is towards an enterprise perspective. The paper identified models such as capability maturity model and the business process maturity model, but highlighted some deficiencies in these models. This was because the technology assessment of the models was mainly based on information-focused analysis (Oztemel and Polat, 2006). Among the important and applicable issues not explicitly addressed in these models are technology forecasting, technology requirements handling, technology change rates, technology portfolio. The technology readiness model for enterprises was developed to address these issues (Oztemel and Polat, 2006).

The proposed technology readiness model forms part of the strategic enterprise resource management methodology (Oztemel and Polat, 2006). This model focuses on three different levels of technological readiness. These are strategic, tactical and operational levels. The technological elements at each level have different weightings in an overall scale (Oztemel and Polat, 2006). In order to measure these levels, certain technology components need to be introduced. These are shown in the figure below. Four technological elements are measured with respect towards these dimensions.

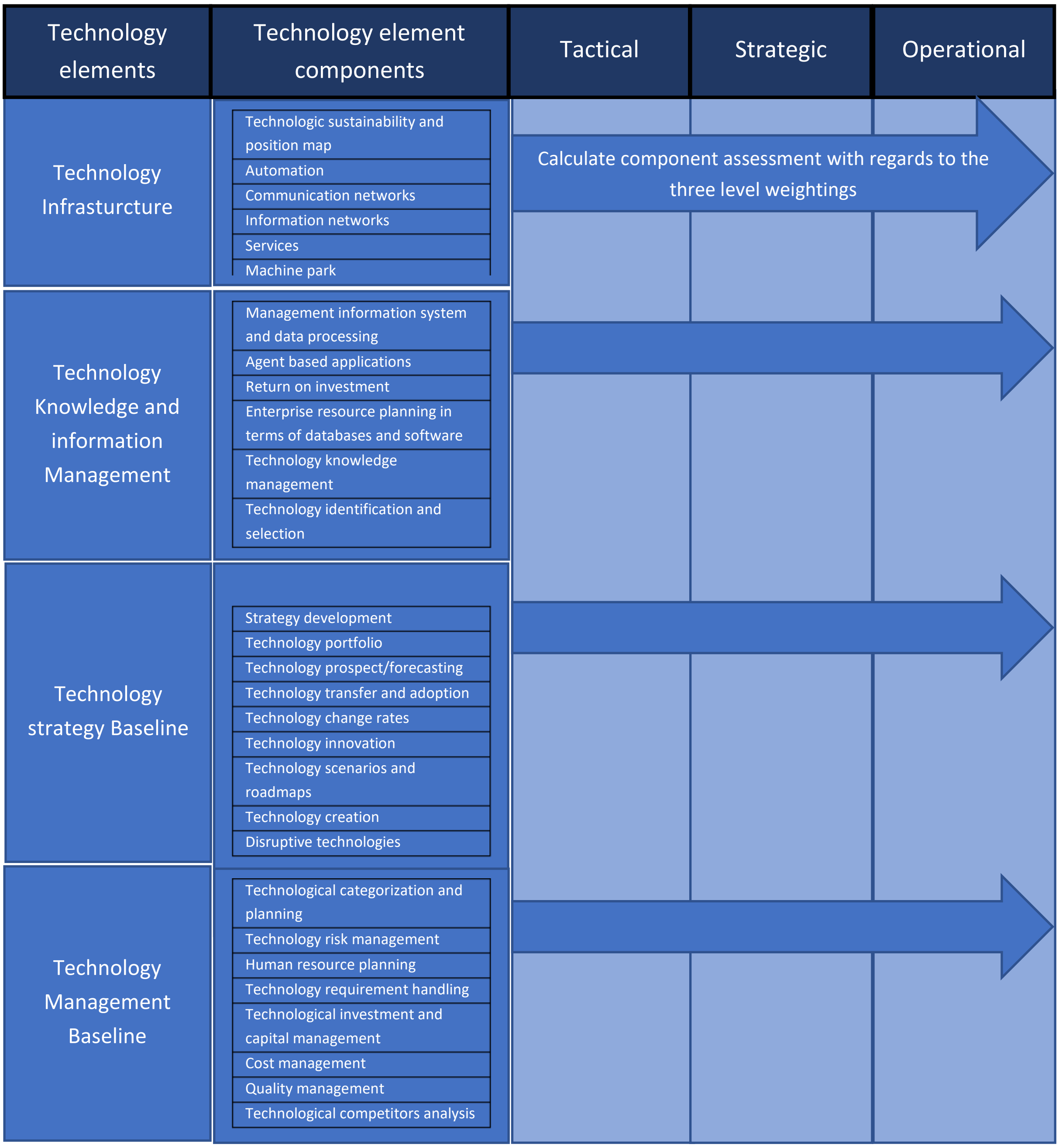

Figure 32. Technology readiness model (Oztemel and Polat, 2006)

Besides the individual elements and elements components, the model offers different views with regards to tactics, operations and strategy. Consideration is thus given to adding these to the proposed readiness model. The characteristics of this model can be seen in the figure below.

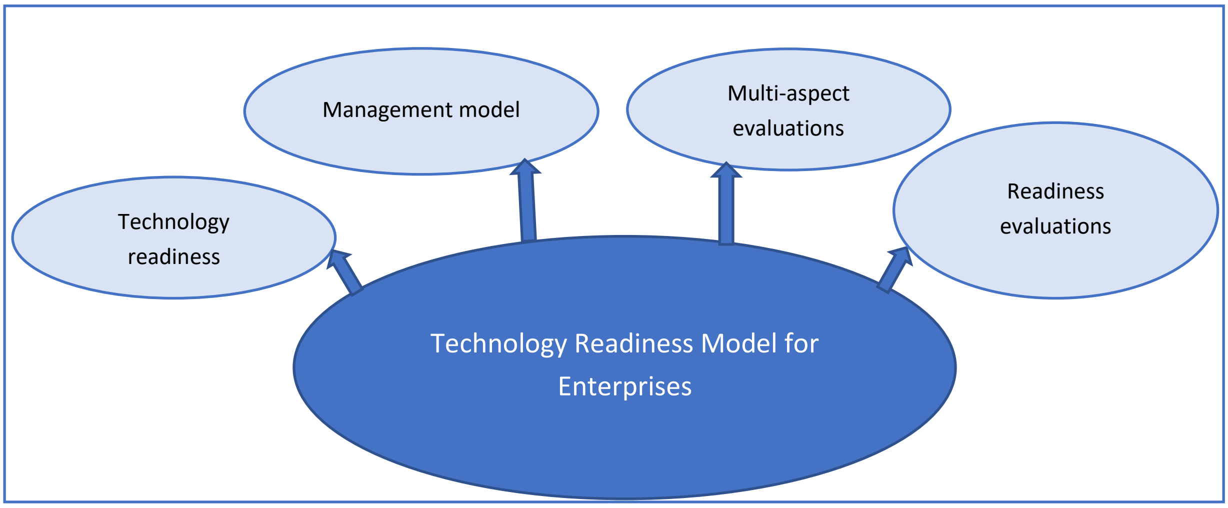

Figure 33. Themes and categories within: Technology Readiness Model for Enterprises

Approved Study 4

Study 4 (Deng, Molla and Corbitt, 2009), "A Fuzzy Logic Based Green Information Technology Readiness Model", focused on presenting a fuzzy logic-based decision model to evaluate an organization, readiness for green IT (Deng, Molla and Corbitt, 2009). This decision model considers the multi-dimensional nature of the identified evaluation problem. The theme considers green information technology as a strategic consideration for businesses that are developing their sustainable practices by balancing both the environmental and economic performance of the organization (Deng, Molla and Corbitt, 2009). For the purposes of this research, the identified study did not focus sufficiently on high level business requirements, operations or management of AI or AI-related themes in the business. The themes can be seen in the figure below.

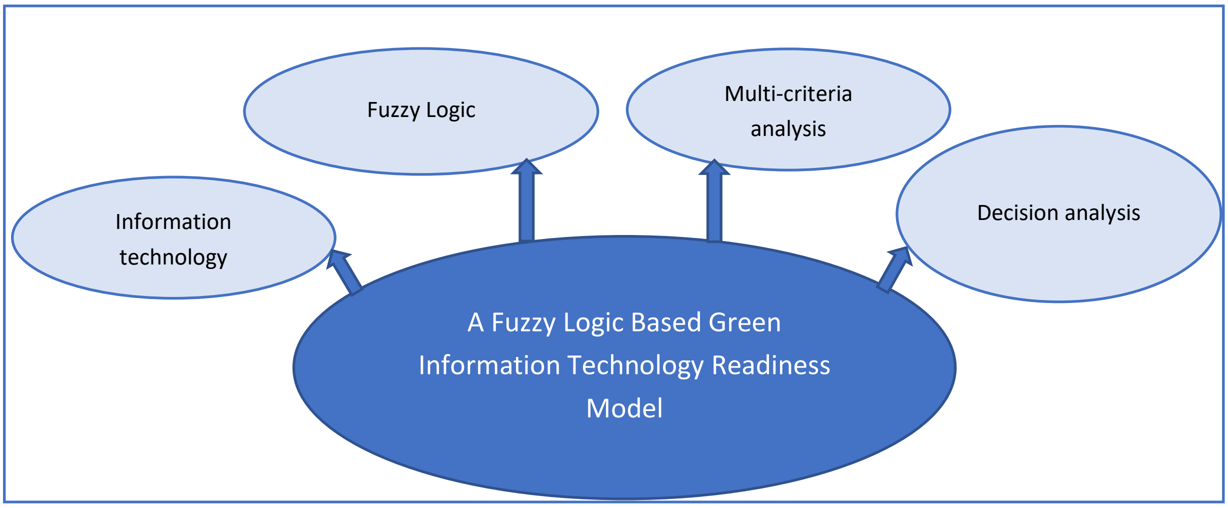

Figure 34. Themes and categories within: A Fuzzy Logic Based Green Information Technology Readiness Model

Approved Study 5

Study 5 (Breck *et al.*, 2018), "The ML Test Score: A Rubric for ML Production Readiness and Technical Debt Reduction", presents 28 monitoring needs and tests that have been developed through experience with a wide range of production machine learning. This helps in quantifying the related issues, as well as presenting a road-map to improve production readiness and pay down machine learning technical debt (Breck *et al.*, 2018). For the purposes of this research, the study did not relate sufficiently in terms of business requirements, operations or management of AI in the business. The identified themes can be seen in the figure below.

Figure 35. Themes and categories within: The ML Test Score: A Rubric for ML Production Readiness and Technical Debt Reduction

4.5 Readiness model dimensions

The purpose of this section is to identify the different models included in the readiness assessment, as well as identify overlapping/shared components and dimensions. The combination of models and literature used to develop the model stems from the systematized and narrative literature reviews. The development of the initial readiness model derives from the integration of readiness models previously identified, coupled with separate research. The illustration of this statement can be seen in Figure 36.

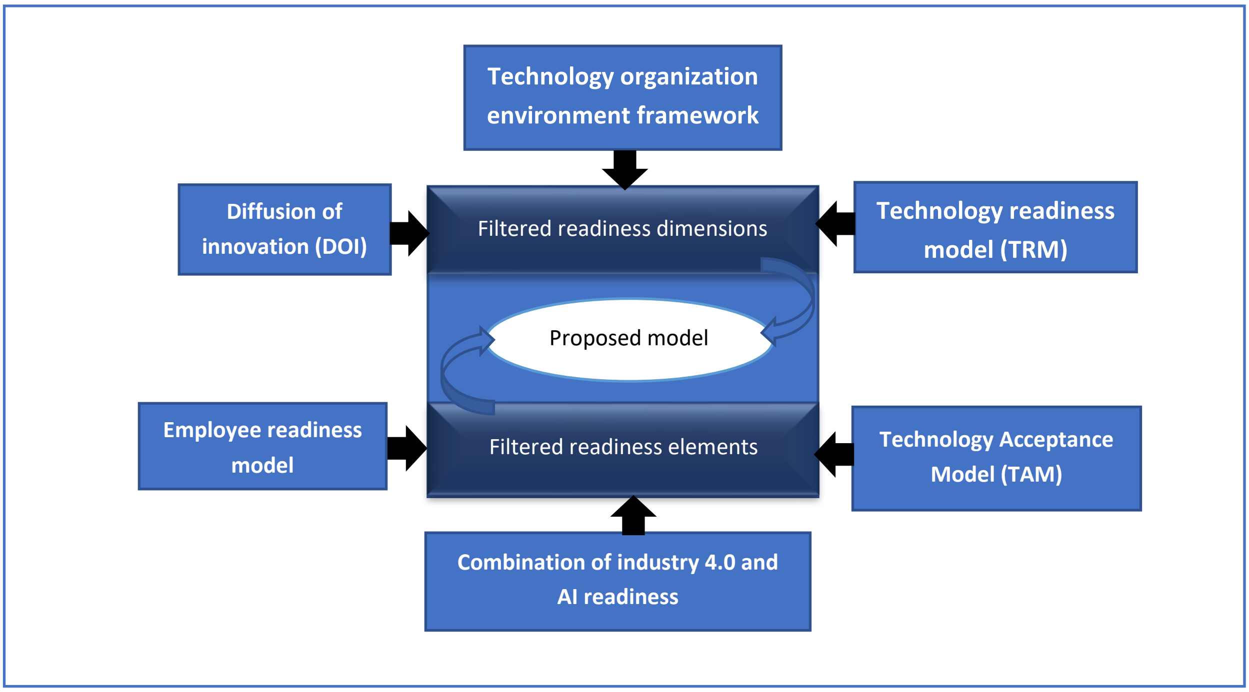

Figure 36. Illustration of model integration

The readiness model dimensions from the previous sections were identified and filtered into recurring readiness dimensions. The readiness elements were also filtered in terms of applicability and generic attributes. The results of the filtering process through the systematized literature reviews and narrative literature reviews can be seen in Appendix A. Table 25 below is generated and identifies where each readiness dimension and readiness element was derived from in terms of its study from the systematized literature reviews. Two further tables indicate the references of the studies within the evaluation table specific to systematized literature reviews. The next chapter will further discuss each of the readiness elements.

Table 23. First systematized literature review studies' references

Academic studies titles	Reference
Digitalization Canvas – Towards identifying digitalization use cases and projects	(Heberle *et al.*, 2017)
Neural networks: An overview of early research, current frameworks and new challenges	(Prieto *et al.*, 2016)
An enterprise risk management knowledge-based decision support system for construction firms	(Zhao, Hwang and Low, 2016)
Determination of Rule Patterns in Complex Event Processing Using Machine Learning Techniques	(Mehdiyev *et al.*, 2015)

Research on quality measuring of CMMI cyclic implementation in software process	(Zhou and Li, 2012)
Managing quality in outsourcing of high-end services: A conceptual model	(Srivastava, Sharfuddin and Datta, 2012)
A model to assess open government data in public agencies	(Solar, Meijueiro and Daniels, 2017)
Computer-aided warehouse engineering (CAWE): Leveraging MDA and ADM for the development of data warehouses	(Kurze and Gluchowski, 2010)
A development process of KMS based on systems engineering methodology	(Xu, 2009)

Table 24. Second systematized literature review studies' references

Academic studies titles	Reference
Employee readiness for acceptance of decision support systems as a new technology in E-business environments; A proposed research agenda	(Ahmed, Qin and Aduamoah, 2018)
The ML test score: A rubric for ML production readiness and technical debt reduction	(Breck *et al.*, 2018)
Cloud readiness assessment framework and recommendation system	(Alemeye and Getahun, 2015)
A fuzzy logic based green information technology readiness model	(Deng, Molla and Corbitt, 2009)
Technology Readiness Model for Enterprises	(Oztemel and Polat, 2006)

The identification table generated below identifies where certain dimensions and readiness elements were found in the accepted studies, this is indicated with a green block.

Table 25. Identification of readiness elements and dimensions from systematized literature reviews

		Literature review studies													
		First systematized literature review (AI maturity)									Second systematized literature review (AI readiness)				
		Study 1: (Heberle *et al.*, 2017)	Study 2: (Zhou and Li, 2012)	Study 3: (Prieto *et al.*, 2016)	Study 4: (Zhao, Hwang and Low, 2016)	Study 5: (Mehdiyev *et al.*, 2015)	Study 6: (Srivastava, Sharfuddin and Datta, 2012)	Study 7: (Solar, Meijueiro and Daniels, 2017)	Study 8: (Kurze and Gluchowski, 2010)	Study 9: (Xu, 2009)	Study 10: (Ahmed, Qin and Aduamoah, 2018)	Study 11: (Breck *et al.*, 2018)	Study 12: (Alemeye and Getahun, 2015)	Study 13: (Deng, Molla and Corbitt, 2009)	Study 14: (Oztemel and Polat, 2006)
Dimension	Employee and culture														
	Technology management														
	Organisational governance and leadership														
	Strategy														
	Infrastructure														
	Knowledge and information management														
	Security														
Readiness elements	Job Security														

	Perceived usefulness														
	Perceived ease of use														
	Compatibility with existing values and practices														
	Benefits														
	Business Acceptance														
	Skills and expertise														
	Collaboration														
	Certainty														
	Technological categorization and planning														

	Technology requirement handling														
	Technological investment and capital management														
	Cost management														
	Technological competitors' analysis														
	Cloud resources														
	Network Connectivity														
	Technology Risk Management														
	Quality Management														
	Human resource planning														

	Executive support														
	Budget														
	Business opportunity														
	Strategic leadership														
	Business cases														
	Trial-ability														
	Business clarity														
	Observable results														
	Technology roadmaps and scenarios														
	Technology prospect/forecasting														

	Agile delivery														
	Technologic sustainability and position map														
	Communication networks														
	Information networks														
	Services														
	Infrastructure platform														
	Management information system and data processing														
	Agent based applications														
	Return on investment														

	Enterprise resource planning in terms of databases and software														
	Technology knowledge management														
	Technology identification and selection														
	Cyber security														

The table above indicated the studies from the systematized literature reviews that contributed to development of the readiness dimensions and elements. The other dimensions and elements were identified through the narrative literature review. The readiness dimensions and elements identified from the systematized literature review were combined specifically with the narrative literature review method from sections 3.4 and 4.3 to form the core dimensions and elements of the study. The elements and dimensions were chosen either because of their applicability to artificial intelligence at a high business level or because each dimension/element had generic relevance to the technology readiness in the business. Combined, these factors contribute to a greater understanding of what would determine a business's readiness for new technology, such as AI. The overall readiness dimensions and readiness elements used can be seen in Appendix A. The next section will focus on developing each of these readiness elements in order to use them more effectively in evaluating a business' readiness.

Chapter 5: Development of the readiness model components

The aim of this section is developing the readiness elements within the determined readiness dimensions. The readiness elements are further discussed on a high level with use of narrative literature review methods. The high-level dissemination was chosen because the complexity of many of the elements almost constitutes a study in their own entity. The aimed outcome of this section is the development of the initial readiness elements and their respective variables. These readiness elements are the elements that have been identified and categorized within the readiness dimensions in the previous chapters.

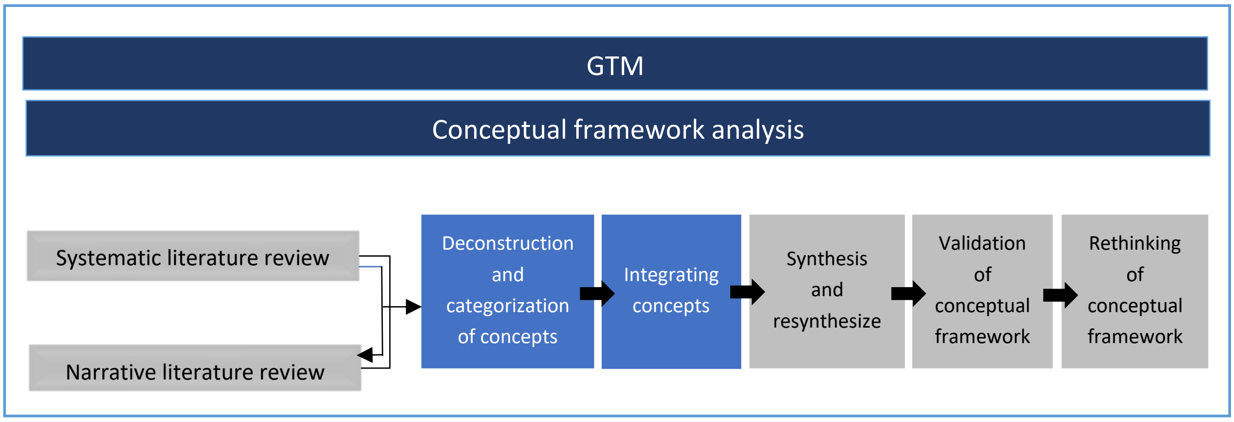

Figure 37. Current Study Methodology Process Step

The two main aims of this section are development of the readiness elements by identifying the readiness variables, as well as to develop the readiness model index. The readiness model index focuses on illustrating the developed readiness dimension, its readiness elements and the readiness variables within these elements. In the future, surveys of the readiness variables will be incorporated into the readiness model to determine a business' readiness performance with regards to AI implementation. The discussion of these readiness elements further enriches the readiness model and provides deeper understanding of each readiness dimension and its inherent elements. The readiness dimensions can be seen in the figure below.

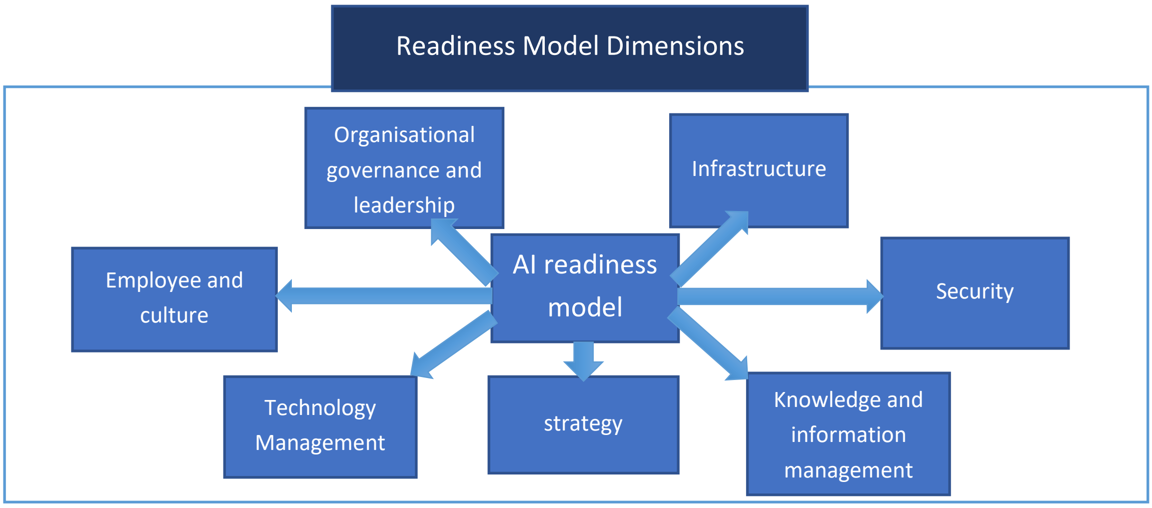

Figure 38. Readiness model dimensions

Each readiness dimension section begins with two figures, which illustratively identify the readiness dimension being addressed and list the order in which the readiness elements within that dimension will be addressed and discussed. This will produce the perspectives and variables to be included in the readiness model for evaluation. The core structure of the readiness model can be seen in Figure 39 below. The arrows indicate the direction that the data gathered about the dimensions, elements and variables was filtered.

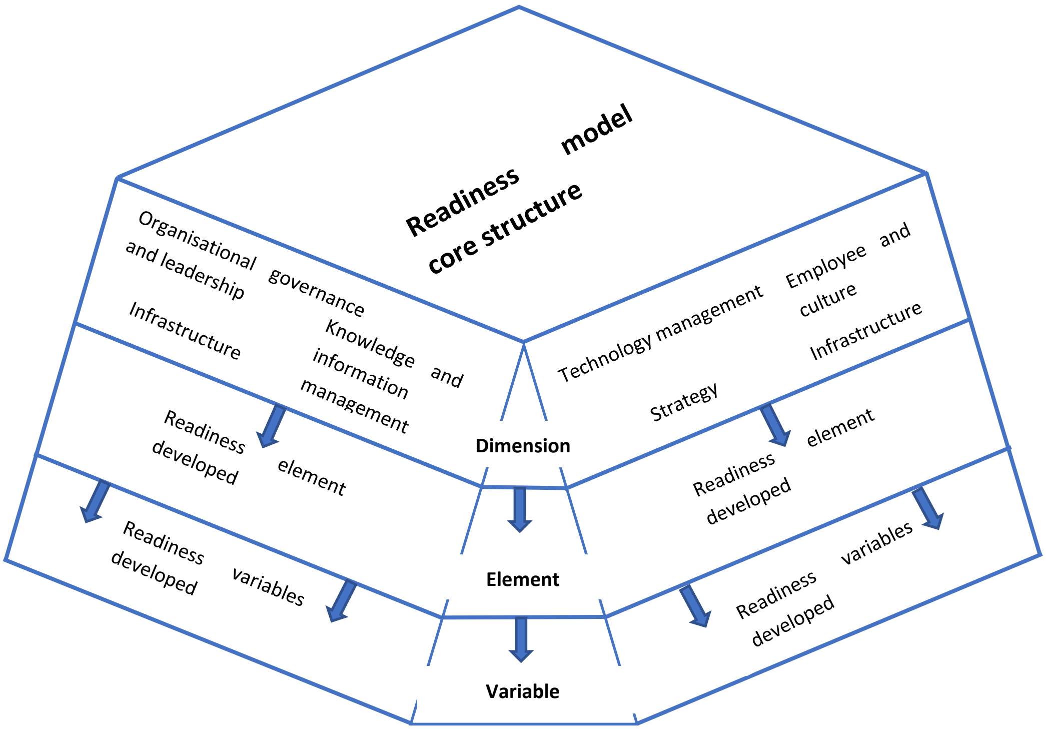

Figure 39. Core structure of the readiness model

5.1 Infrastructure Dimension of readiness model

Infrastructure dimension obtained from (Oztemel and Polat, 2006). forms part of a crucial aspect with regards to this readiness model. Due to that general perspective of infrastructure being the acquisition or owning of essential facilities, services, structures and services to enable effective work (Cambridge, 2019c). From Figure 41, It can be seen that the identified and categorized elements which forms part of this dimension consists of Infrastructure platform, services, Information networks, communication networks and technological sustainability and position map. These elements will be further discussed on a high level using some narrative literature review methods.

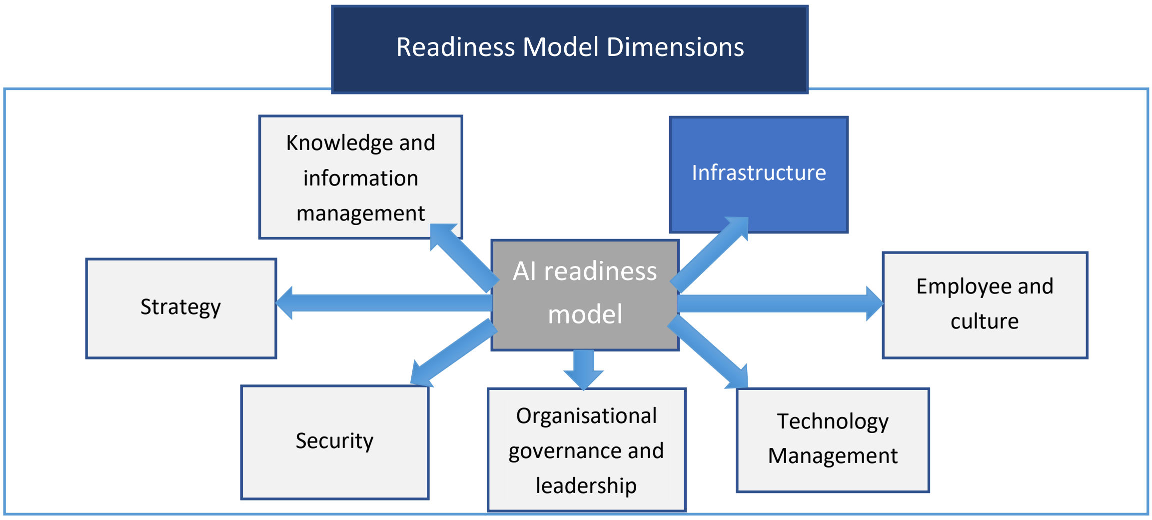

Figure 40. Infrastructure readiness dimension identification

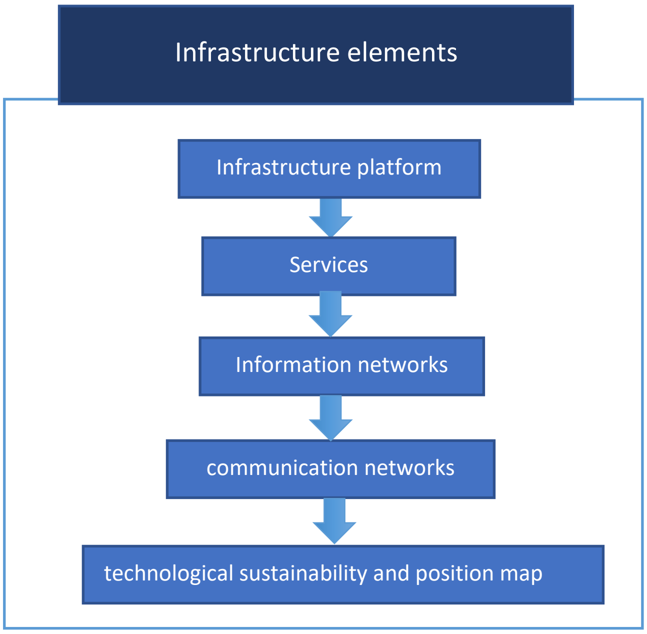

Figure 41. Infrastructure readiness elements

Infrastructure platform

The infrastructure platform is identified in (Intel, no date a). Some insights into infrastructure and architecture related items with regards to artificial intelligence implementation was identified. These infrastructure related items consist of the identification server infrastructure with regards to GPU performance and capability, the identification of storage with regards to data and software, identification of relevant/required data sources, centralization of computing and storage resources (Lui and Karmiol, 2018). An important aspect identified was the identification of the importance of data sources (Lui and Karmiol, 2018). Data sources are an important factor when implementing types of AI, such as machine learning, natural language processing, deep learning (neural networks) or support vector machines. There should be a large focus on the data that is being used with regards to these models, being it to train/learn the models or to use it to gather information or generate value from the inputted data. Ultimately the selection of these identified infrastructure items, is determined through the business' strategic decision on whether the business wishes to incorporate SaaS (software as a service), Paas (platform as a service), Iaas (Infrastructure as a service) or whether to manage all the infrastructure related items/elements on-premises of the business. The focus for this readiness element will be whether the business has identified the strategic route it will take, with regards to Paas, Iaas and Saas and has initiated the process of requirement identification.

Services

With regards to this study, the services readiness element identified in (Oztemel and Polat, 2006), mainly focuses on the services that has been identified in the business, which will be potentially affected and targeted by the implementation and operation of AI in the business. The identification of these services also encourages process mapping, which could serve as an important tool to more effectively and efficiently implement AI in the business processes. The other important perceived aspect would be the development of use cases for this technology within the business. The main focus of this element whether the business has identified and mapped services that will be targeted or influenced by the implementation or operation of AI.

Information networks

With regards to this study, the Information network readiness element is identified in (Oztemel and Polat, 2006). Data, informal objects, groups, individual agents and components are interconnected and interact with one another. The leads to the creation and formation of large, sophisticated and interconnected networks. These interconnected networks are referred to as information networks (Sun and Han, 2013). Some examples are: social networks, world wide web, research publication networks, highway networks and biological networks. Therefore, information networks from an integral part of information infrastructure. It is thus important to identify which parts of the information system will be affected/used in the implementation and operation of artificial intelligence. Depending on the type of

AI and the aim/outcome of the AI, the information system and network could be accessed, altered and affected from various points within the system. The main focus of this element is thus the identification of information networks that is potentially involved/affected by the implementation, operation and management of AI.

Communication networks

With regards to this study, the Communication network readiness element is identified in (Oztemel and Polat, 2006). Communication networks provide the required infrastructure, which enables a utility to manage devices from a central location in a smart grid environment. When managing heterogenous communication technologies and architecture in enterprises, communication networks should meet the requirements of latency, bandwidth, security and reliability (Kuzlu, Pipattanasomporn and Rahman, 2014). It is thus important to identify which parts of the communication network will be affected/used in the implementation and operation of artificial intelligence.

Technological sustainability and position map

With regards to this study, the Information network readiness element is identified in (Oztemel and Polat, 2006). In its basic form, the position map and more specifically, the price-benefit positioning map indicates the relationship between the prices of all products in a specific market and the primary benefit that the product delivers to the customers (D'Aveni, 2007). The maps are developed using three phases. These phases are: defining the market; choosing a price and determine the primary benefit; plotting positions and drawing up the expected-price line.

Defining the market phase, begins with identifying customer needs, which you wish to better understand. Analysis of current products that satisfy those needs should be broad in order to reduce risk of being outperformed in the future by new entrants and technologies. The next is identifying the region in which to conduct the study in. The final part is making the decision on whether to track a segment of the market or the market in its entirety for a product (D'Aveni, 2007).

In order to determine a price and determine the primary benefit, specifying the scope of analysis of prices needs to be done. This includes determining the pricing parameters. This is accompanied with the identification of the primary benefits, thus the benefit that results in the greatest variance in prices. List of benefits that other products offer and customers perceptions on these benefits should be identified. One method is using regression analysis on the collected data, to identify which benefit causes the most variance in prices (D'Aveni, 2007).

Plot positions and draw expected-price line phase, encompasses the development of position map by plotting the positions of each company's product with relation to its price and the level of its primary benefit. An expected price line, which best fits the data is determined. This should provide some simplified insights into the topic of primary benefits relationship to pricing (D'Aveni, 2007).

In terms of technological sustainability, a Technological sustainability assessment conceptual framework was identified. The systems approach to sustainability assessment (SATSA) integrates three main elements, namely technology development, sustainable development and dynamic systems approach (Musango and Brent, 2011). The schematic representation of these elements can be seen in the figure below.

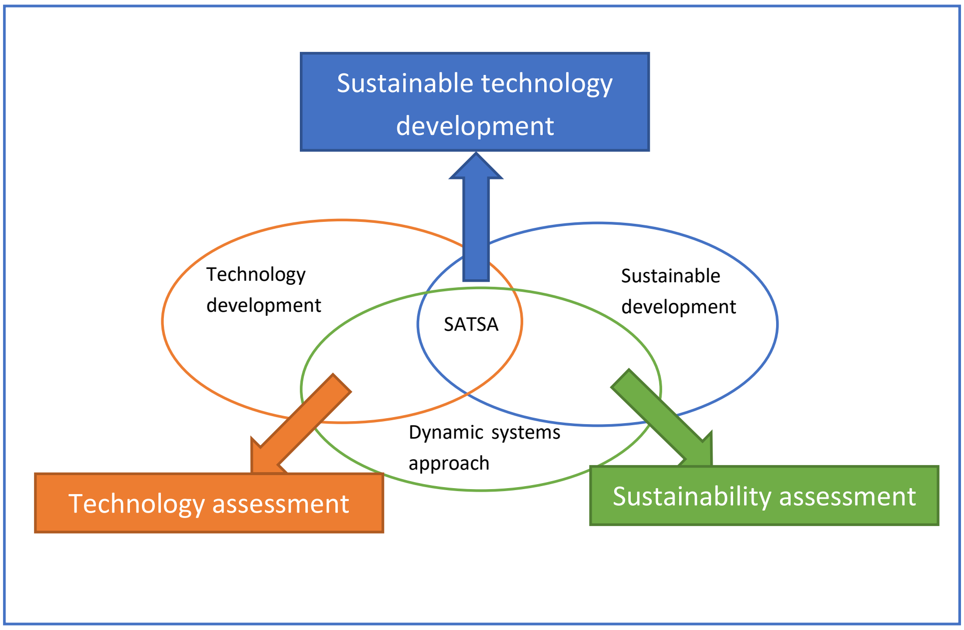

Figure 42. Schematic of a systems approach to technology sustainability assessment (Musango and Brent, 2011)

With regards to this study the main focus of this readiness element will be on whether the business has started developing a technological position and sustainability map with regards to AI related technology and services.

5.2 Employee and culture dimension of readiness model

The employee and culture dimension identified in (Ahmed, Qin and Aduamoah, 2018), (Schumacher, Erol and Sihn, 2016), allows for inputs from a employees' perspective with regards to new technologies, such as artificial intelligence. The dimension and relevant elements can be seen in Figure 43 and Figure 44 below. The employee and culture perspective provides the readiness model and the business using the model with interesting perspectives into what the employees and people expect and perceive of AI. Looking back at Figure 3, an easy assumption to make is that general expectations surrounding AI and its applications are still exaggerated and inaccurate. This readiness dimension is vital, due to that if employees have negative views/perspectives with regards to a new technology. Those employees won't be as motivated to assist in the implementation, operation and management of AI. The result could cause large delays in project timelines. Assuming these are the same individuals/employees that form part of processes in which AI will be present, individuals could potentially see AI as a risk rather than an asset, which further shows the importance of managing people's expectations with regards to AI. The main focus of this section is to measure various different perspectives from employees with regards to AI.

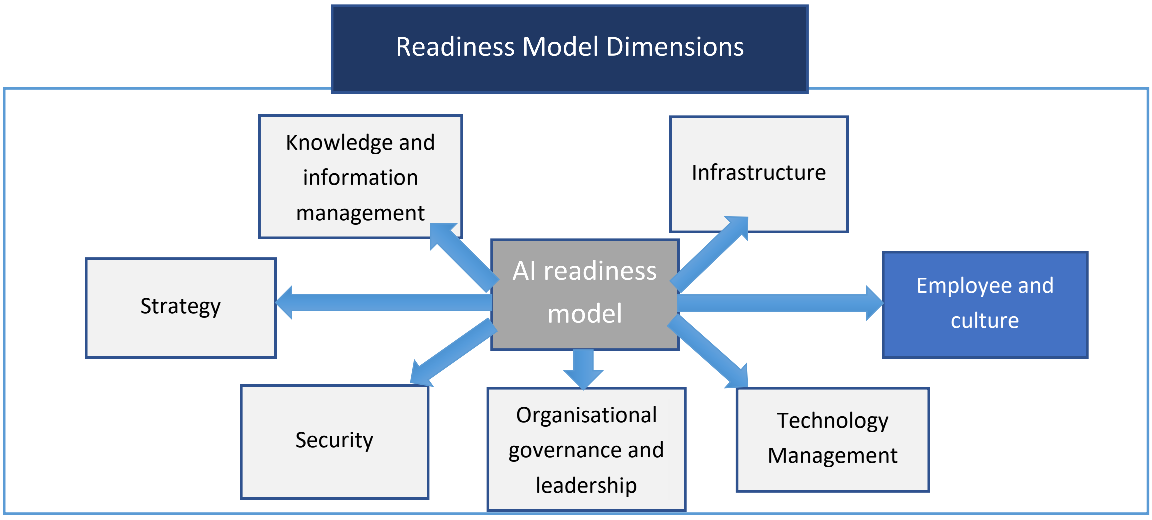

Figure 43. Employee and culture readiness dimension identification

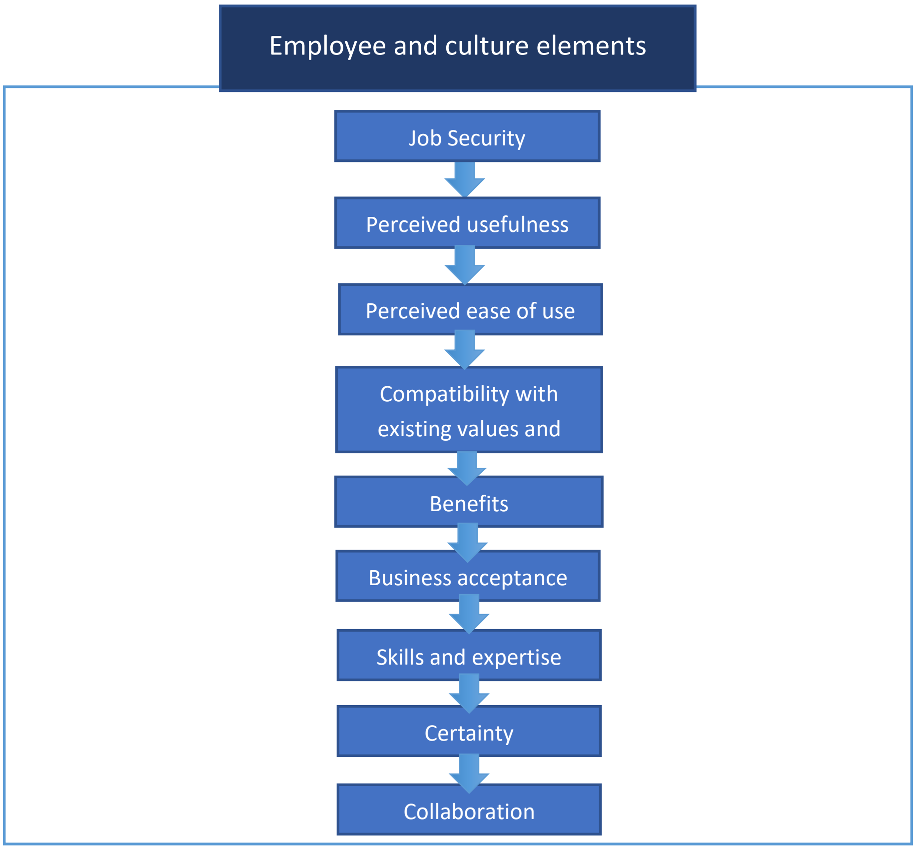

Figure 44. Employee and culture readiness elements

The job security element focuses on the employees' perceptions on job security with regards to artificial intelligence (Ahmed, Qin and Aduamoah, 2018). Perceived usefulness encompasses employees' perceptions on the usefulness of AI [29,30]. Perceived ease of use encompasses the employees' perceptions on how easy it is to use artificial intelligence [29,30]. The compatibility with existing values and practices focuses on the compatibility of AI (digitized culture) with a business's current practices and values (Alemeye and Getahun, 2015). The benefits element comprises of the perceived benefits AI provides for employees, when incorporating this technology (Ahmed, Qin and Aduamoah, 2018). The business acceptance element focuses on the perceived acceptance of the business with regards to AI (Ahmed, Qin and Aduamoah, 2018). The skills and expertise section focus on the perceived current skills and expertise capability of the business with regards to implement and manage AI (Intel, no date a). The certainty element comprises of the perceived trust/certainty that the management and employees have in AI (Ahmed, Qin and Aduamoah, 2018). The collaboration element encompasses the willingness of employee collaboration with regards to implementation and management of AI (Ahmed, Qin and Aduamoah, 2018).

5.3 Technology management

The management of technology as a dimension is identified in (Alemeye and Getahun, 2015), (Oztemel and Polat, 2006), (Schumacher, Erol and Sihn, 2016). This dimension requires integrating a multitude of activities across different sectors of the organisation. Due to increasingly high-velocity environments, many corporations struggle with this task. As example, research and development groups often have strained relationships with the other divisions/areas in the business (Levin and Barnard, 2008). Thus, technology management is an important dimension in effectively determining a business's readiness. The readiness elements previously identified and categorized can be seen in Figure 46.

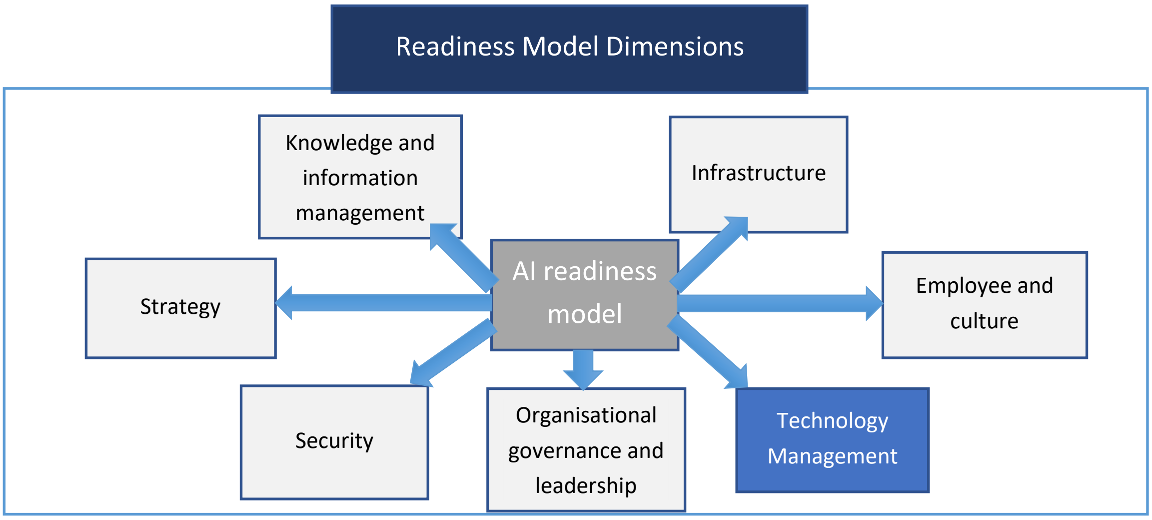

Figure 45. Technology management readiness dimension identification

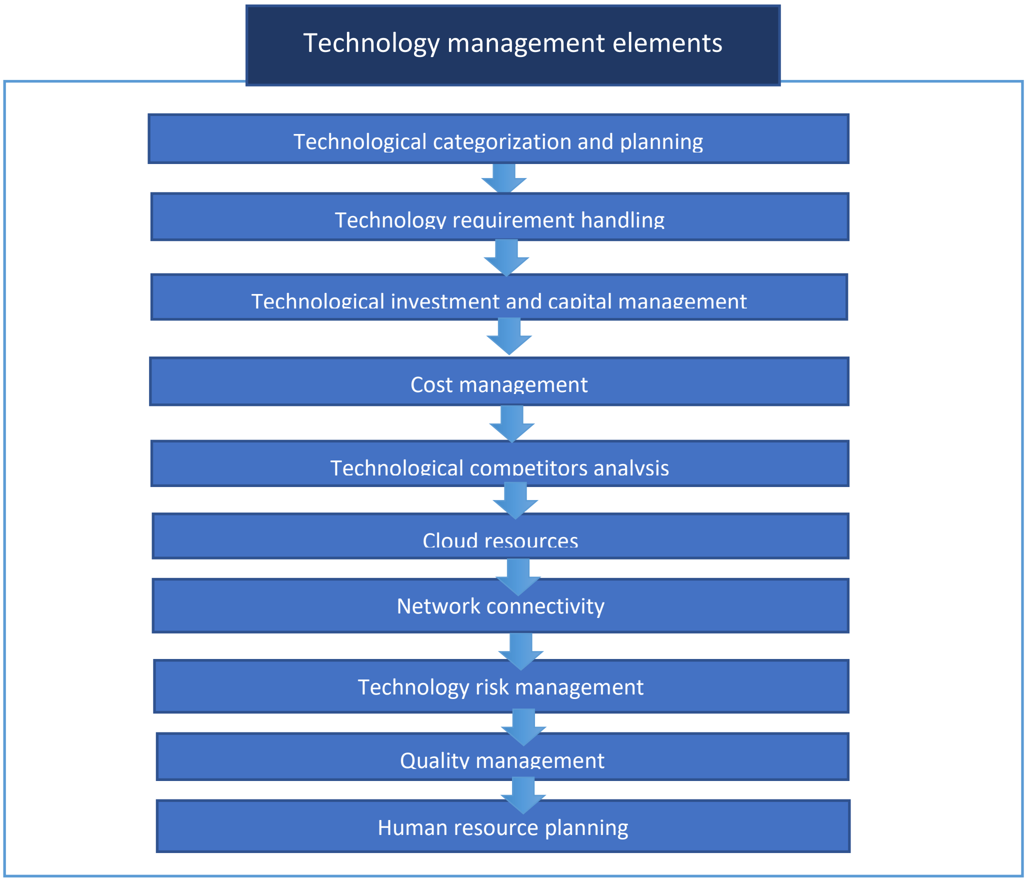

Figure 46. Technology management elements

Technological categorization and planning

With regards to this study, the Technological categorization and planning readiness element is identified in (Oztemel and Polat, 2006). The technological categorization and planning of AI will assist in providing guidelines/roadmap for implementation of this technology. The decision to select a technology is a construct at the centre of information system field (Ellis *et al.*, 2016). The study (Ellis *et al.*, 2016), developed a framework of technological categories based on work originating from the technology acceptance model. Multi-dimensional scaling and cluster analysis were utilized, which aggregates the selection of individual sorters. This develops statistically constructed hierarchical clusters (Ellis *et al.*, 2016). The categories identified are:

- Communication
- Healthcare
- Academic support
- Mobile
- DSS, Expert and ERP
- Education and training
- General internet and web
- Social networking and virtual communication
- Security and government
- Online auctions and trading
- End-user computing and adoption of new technologies in the workplace
- Business operations
- E-commerce and online shopping
- Self-service systems
- Banking and financial services
- Voice enabled web applications
- Mobile banking and payment
- General computer usage
- Productivity software
- Development tools and methodologies
- Data management
- Enterprise software
- Internet services
- Entertainment
- Business support services

The technological categorization and planning of AI will assist in providing guidelines/roadmaps for implementation of this technology. The main focus of this readiness element with regards to the study is the progress, the business has made with regards to categorization and planning of the aimed AI technologies.

Technology requirement handling

Requirement management is needed to effectively handle the requirements of technology and how these are related to parts of it (Svensson and Malmqvist, 2001). This forms especially part of planning with regards to AI implementation. The main focus thus being on whether the business has identified or constructed requirement management structures, such as the identification of prospective individuals/managers, as well as initiation of requirement determination on different levels within the business with regards to AI (Oztemel and Polat, 2006).

Technology investment and capital management

A key element in the technology management dimension, is technology investment and capital management (Oztemel and Polat, 2006). For this study in terms of readiness for artificial intelligence. The aspect that will be included is, the fact of whether the business has allocated resources towards technological investment and capital management for artificial intelligence in the business.

Cost management

Costs need to managed intelligently and aggressively in a non-sustainable competitive advantage environment (Oztemel and Polat, 2006). Effective cost management (cost accounting systems and information) should provide a multi-dimensional focus on multiple cost objects such as, processes, customers, products, activities, services and functions (Kulmala, Paranko and Uusi-Rauva, 2002). There should also be more focus on cost control and planning rather than monitoring. The cost management structure should provide support for key business decisions, such as pricing, investment justification, efficiency, sourcing, product elimination, new product introduction and productivity measures. The main focus of this readiness element with regards to the study is on whether the business has identified cost management structures with regards to the AI project.

Technological competitors' analysis

Most managers acknowledge the importance of understanding their competitors and industry. There are various competitive analysis techniques can formulate and implement strategy (Sohel, Rahman and Uddin, 2014); the following are some examples strategy (Sohel, Rahman and Uddin, 2014):

- SWOT analysis
- Boston Consulting Group Approach

- Porters five forces & value chain analysis
- SPACE matrix
- Mckinsey's Industry strength matrix
- General electric stoplight strategy
- External factor evaluation matrix
- Internal factor evaluation matrix
- PESTEL analysis
- Competitive profile matrix

This forms an important aspect with regards to determining potential opportunities and threats with regards to leveraging artificial intelligence to generate business value (Oztemel and Polat, 2006). The main focus of this readiness element is how far the business has progressed in conducting a thorough technological competitor analysis.

Cloud resources

According to the literature discussed earlier, Cloud resources are seen as important enablers for a business seeking to fully exploit the potential and ease of use of its AI. Cloud computing assists IT departments and developers in focusing on value adding tasks, thus avoiding work, such as procurement, maintenance and capacity planning (AWS, 2019). There are three main types of cloud computing models and deployment models. The models are: Infrastructure as a service (IAAS), Software as a service (SAAS) and platform as a service (PAAS) (AWS, 2019), (Noor *et al.*, 2014). The cloud computing deployment models are: cloud (complete), hybrid and on-premises models (AWS, 2019). The computing and deployment models can be seen in Table 26 and Table 27 below.

Table 26. Cloud computing models

Type of cloud computing model	Description
IAAS	This model contains basic building blocks for cloud IT. Usually access is provided to data storage spaces, computers (hardware and virtual) and networking features (AWS, 2019), (Hwang and Li, 2010),(Bamiah and Brohi, 2011). Similar to existing IT resources of today.
PAAS	Removes the need to manage infrastructure, such as hardware and operating systems. Focus can be shift towards management and deployment of applications (AWS, 2019), (Hwang and Li, 2010), (Bamiah and Brohi, 2011).

SAAS	Provides a completed product or browser-initiated application software which is managed by the service provider. Another description is that the provider facilitates the clients with applications, which runs on cloud infrastructure through a thin client interface (AWS, 2019), (Hwang and Li, 2010), (Bamiah and Brohi, 2011).

Table 27. Cloud deployment models

Type of cloud computing deployment model	Description
Cloud	The application id fully deployed and run in the cloud. These were either created in the cloud or migrated from an existing infrastructure (AWS, 2019).
Hybrid	Hybrid deployment model is the connection of applications and infrastructures between on-premises or off premises private cloud infrastructure and the public cloud (AWS, 2019), (Bamiah and Brohi, 2011).
On-premises	On premises deployment, through the use of virtualization and resource management tools. This however does not provide many of the benefits of using cloud computing (AWS, 2019).

The main focus of this readiness element with regards to the study, is divided into four parts these being the identification and selection of a cloud computing model, such as Paas, Iaas and Saas, as well as the requirements for implementing either of these computing models. The other two parts being the identification and selection of the cloud deployment models, such as cloud, hybrid and on-premises, as well as the requirements with regards to facilitating either of these deployment models.

Network connectivity

The implementation and operation of AI could require new network connections, thus the identification of the required network connectivity within the business to assist or enable AI in the business is essential towards successfully determining the business' readiness for artificial intelligence. This element was identified in (Alemeye and Getahun, 2015). The main focus of this readiness model, is whether the business has identified the required network connectivity changes in the business.

Technology Risk management

The technology risk management element is identified in (Oztemel and Polat, 2006). The technology risk management guidelines (MAS - TRMG) framework is important to be established to assist in manging technology risks in a systematic manner (Singapore, 2013). The following are important attributes should be included within this management structure (Singapore, 2013):

- Responsibilities and roles for managing technology risks
- Prioritisation and identification of information system assets
- Implementation of practices and controls to mitigate risks
- The identification and assessment of the probability, as well as the impact of current and emerging threats, vulnerabilities and risks
- Periodic improvement/update and monitoring of risk assessment to include changes in systems, operating/environmental conditions that could affect the risk analysis

To achieve data confidentiality, system security, reliability, recoverability and resiliency, effective risk management practices and internal controls need to be instituted (Singapore, 2013). An important component in technology risk management is risk assessment. Risk identification is an important part of the risk assessment. There are various methods/tools to identify the risks associated with a project, two of these methods are brainstorming and risk identification through the use of process flowcharts. The risk consequence and matrix method are used for the risk assessments. A risk matrix is a structured perspective that provides a methodology to assess impacts of risks and determine which risks are critical to the project (Garvey and Lansdowne, 1998). An example of a risk matrix is shown in the figure below.

Impact	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
	0	1	2	3	4	5
	Probability					

Figure 47. Impact vs Probability Risk matrix

The impact criterion's 1 to 5 values range from negligible, minor, moderate, significant and severe respectively. The probability criterion's 1 to 5 values indicate very unlikely, unlikely, possible, likely and very likely. The list of identified risks is given an estimated impact and probability rating of 1 to 5. The risk consequence is determined by the formula below.

$$\text{Risk consequence} = \text{likelihood} \times \text{Impact}$$

This provides a simple, quick and effective way for business to identify and prioritize risks, this prioritization of the risks can assist business in resource planning with regards to risk management.

Quality management

To ensure that all activities and processes with regards to artificial intelligence in terms of implementation, operation and management, the appropriate quality management structures need to be identified and put into place to ensure a continuous level of excellence throughout the project's duration and future developments (Oztemel and Polat, 2006). To better understand quality and quality management, the first part is understanding what is quality. From a survey conducted, which included managers of 86 firms, several dozen definitions were provided to describe quality. Some of the responses were (Evans and Lindsay, 2017):

- Consistency
- Perfection
- Speed of delivery
- Eliminating waste
- Doing it right, the first time
- Pleasing customers
- Providing good/usable products

The next aspect with regards to quality and quality management, it is important to identify from which perspective, one views quality. Quality can be defined from six different perspectives (Evans and Lindsay, 2017):

- Product
- Transcendent
- Value
- User
- Manufacturing
- Customer

Lastly some quality management principles have been identified to better assist and align one's goal towards an effective and efficient quality management structures. These quality management principles are (Evans and Lindsay, 2017):

- Principle 1: Customer focus
- Principle 2: Leadership
- Principle 3: Involvement of people
- Principle 4: Process approach
- Principle 5: System approach to management
- Principle 6: Continual improvement
- Principle 7: Factual approach to decision making
- Principle 8: Mutually beneficial supplier relationships

The field of quality management with regards to technology, implementation, operation and management is very broad and complex. It is thus decided that the main focus of this readiness element with regards to the study, is whether the business has identified and selected quality management structures with regards to AI implementation, operation and management.

Human Resource Planning

Human resource planning was identified in (Oztemel and Polat, 2006). Human resource planning forms part of the primary practice of human resource management. Human resource planning forms part of an important role in forecasting future demands of a business, as well as environmental factors. It also assists in managing human resource demands (Aslam *et al.*, 2014). It is stated that objectives of an organization are achieved through proper planning, thus data collection about goals and objectives is conducted before arranging resources, people and other competencies required to complete the objectives (Aslam *et al.*, 2014). The two main focuses of this readiness element with regards to this study is, whether the business has documented data regarding the short to long term goals of the AI project, due to this being a pre-condition for arranging people and resources, as well as the identification of the required resources, people and competencies to implement and operate the technology and project.

5.4 Organizational governance and leadership

The organizational governance and leadership dimension was identified in (Heberle *et al.*, 2017), (Alemeye and Getahun, 2015), (Schumacher, Erol and Sihn, 2016). This forms an important part with regards to determining and facilitating the long-term strategy and goals of the business. When considering the implementation of artificial intelligence into the business, one can conclude it forms part of the digitization goals of the business. These individuals are thus vital to facilitate the successful implementation and operation of AI on different levels of the business. In terms of organizational governance and leadership, the identified readiness elements within the dimension can be seen in Figure 49.

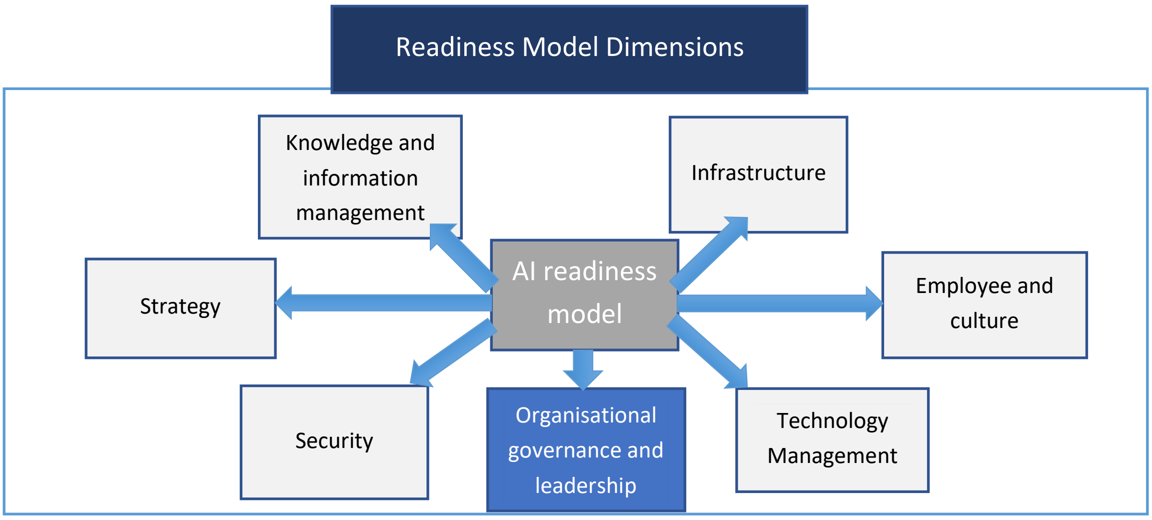

Figure 48. Technology management readiness dimension identification

Figure 49. Organisational governance and leadership elements

Executive support

Executive support as a readiness element is identified in (Heberle *et al.*, 2017), (Alemeye and Getahun, 2015) In terms of this study the executive support comprises of the level of support individuals in management and governance position provide with regards to the implementation, operation and management of AI in terms of strategic assistance, funding, cooperation and becoming a main driver in business with regards to this topic. There are executive support systems are a reporting software tool, which uses the organization's data into useful summarized reports. These reports are usually used by executive level managers (Chichernea, no date). The main focus of this study with regards to this study is level of executive support is provided towards driving the completion of the implementation, operation and management of AI.

Budget

Budget as a readiness element was identified in (Heberle *et al.*, 2017), (Alemeye and Getahun, 2015). A basic definition of budget is: A plan to show how much money an organization or person will earn and how much they will need or be able to spend (Cambridge, 2019a). A basic requirement for implementing an artificial intelligence project into business, is the allocation of a budget for the project to cover all expenses associated with the implementation, operation and management of this technology.

Business opportunity

Business opportunity as a readiness element was identified in (Intel, no date a). Business opportunity can be defined as an opportunity/chance to meet a market need/demand through the use of creative combinations of resources to deliver superior value (Bolt, 2014). This should be an important aspect with regards to early strategic positioning of the business with regards to AI. It is important to identify the need/demand you want to more effectively/efficiently meet, as this could focus the where in the business opportunity for AI could be identified in the business. The main focus of this readiness element, is thus whether the business has identified business opportunities for AI.

Strategic leadership

Strategic leadership as readiness element was identified in (Intel, no date a). Strategic leadership forms an integral part for the implementation of new technologies within the business, both from a strategic and support point of view. With regards to strategy, important activities that should be addressed by strategic leadership, are direction setting, translation of strategy into action, aligning the organization and the people with the developed strategy, development of strategic capabilities and determining the effective intervention points (Davies and Davies, 2004). The aimed characteristics that a strategic leader should have are, restless with the present, prioritize their strategic thinking and learning, develops mental models to frame their own practice and understanding and has powerful/influential professional and personal networks (Davies and Davies, 2004). The main focus of this readiness element is, whether the business has identified the required strategic leadership, which complies with the activities and characteristics of a strategic leader.

Business cases

The definition of a business case: a set of reasons describing how a business decision will improve a product or business, as well as how it will affect costs and profits and attracting investments (Cambridge, 2019b). This readiness element forms an integral part of identifying AI's viability and potential value that it can generate for the business to stakeholders /managers and governing bodies.

The main focus of this readiness element is, whether the business being evaluated has identified business cases for AI.

5.5 Security

Cyber security as a readiness element was identified in (Intel, no date a). Cyber security has evolved from a specific technical discipline into a strategic concept (Geers, 2011). Even at the tactical level, cyber security is still a highly technical discipline (Geers, 2011). Problems regarding cybersecurity are approached typically from the technical, information technology perspective (Tisdale, 2015).

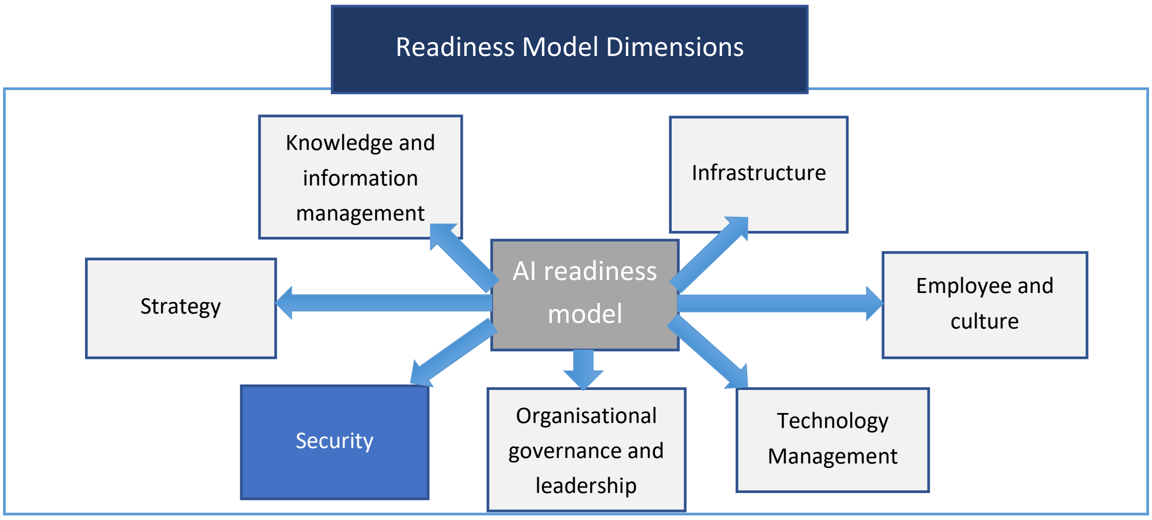

Figure 50. Organisational governance and leadership readiness dimension identification

Recent research shifts the focus towards comprehensive approaches, which considers business objectives, risk management, organizational psychology and governance (Tisdale, 2015). Cyber security forms particularly part of knowledge management problems, given the amount of data, perishability of data, technology turnover and multitude of information involved (Tisdale, 2015). Here is a cyber security management framework developed from study in (Tisdale, 2015). Which helps identify important sections and elements with regards to this topic.

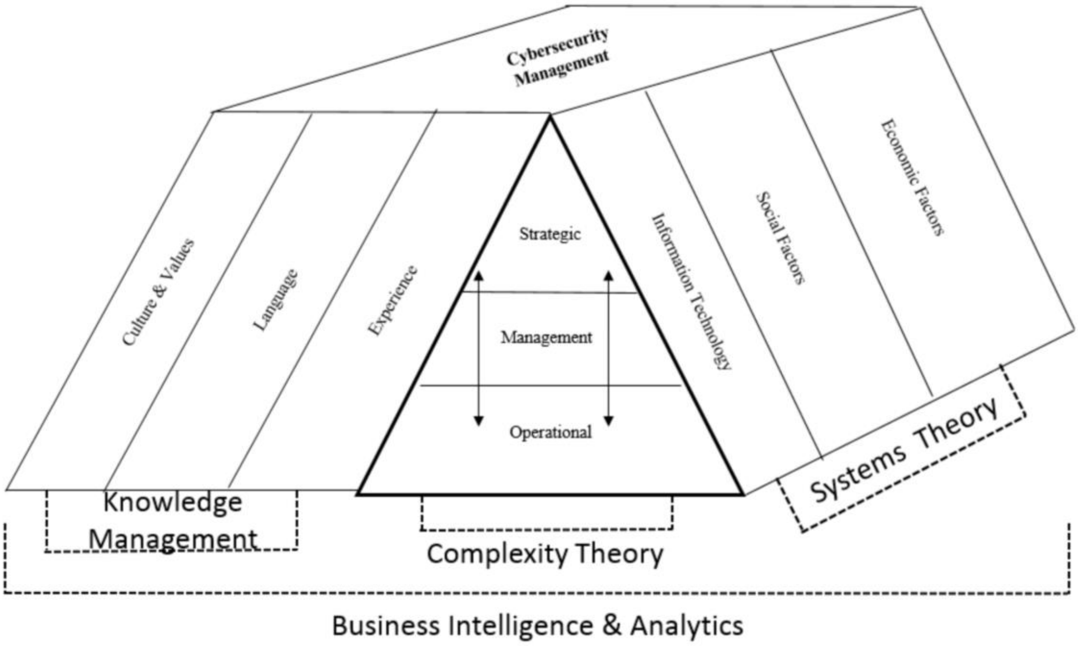

Figure 51. Cyber security management framework (Tisdale, 2015)

The main focus of this readiness model with regards to the study, is whether the business being evaluated has identified and developed management structures for cyber security with regards to AI being implemented into the business.

5.6 Strategy

The strategy dimension is identified in (Oztemel and Polat, 2006), (Intel, no date a), (Schumacher, Erol and Sihn, 2016). This dimension focuses on readiness elements that are vital towards planning and directing short to long term goals of business with regards to the implementation, operation and management of AI. In terms of Artificial intelligence readiness elements related to strategy, the list of these elements can be seen in Figure 53, as well as the current readiness dimension with relation to the other dimensions can be seen in Figure 52.

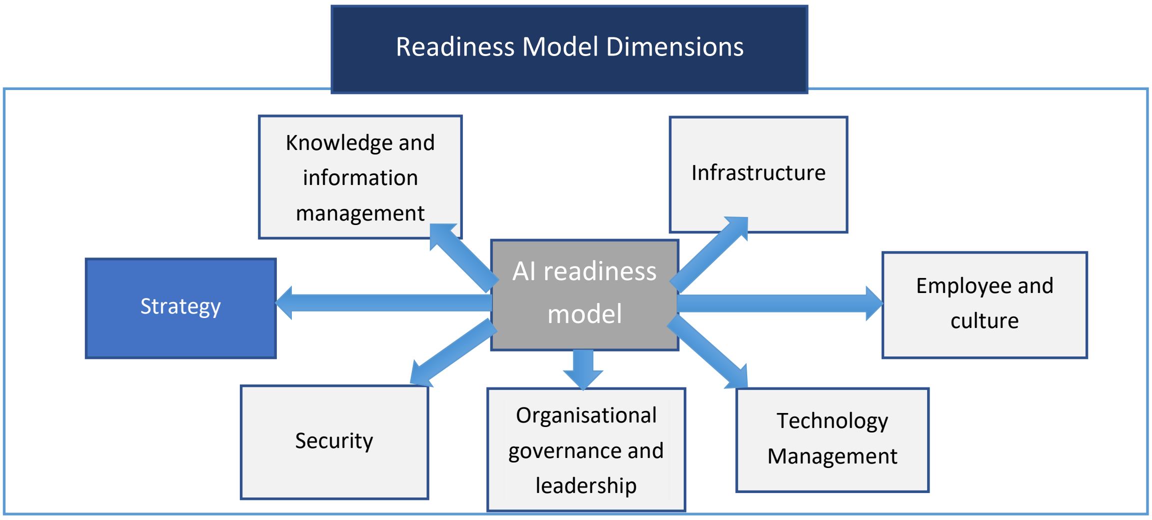

Figure 52. Strategy readiness dimension identification

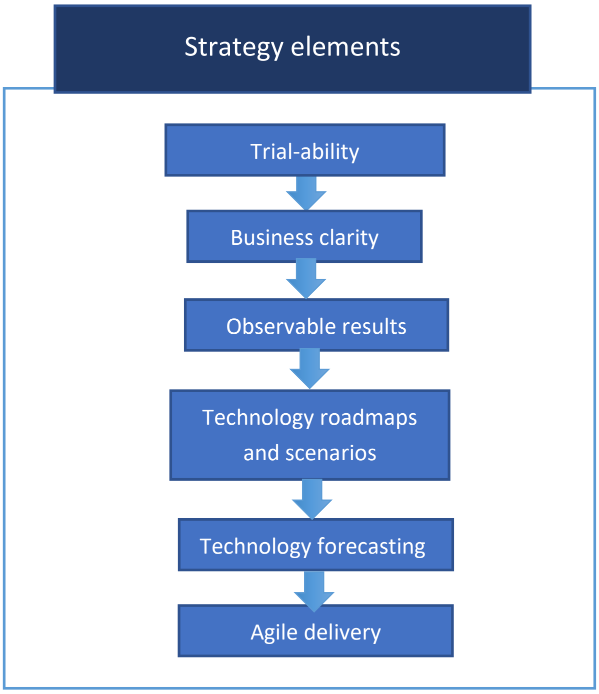

Figure 53. Strategy readiness elements

Trial-ability

Identified in (Alemeye and Getahun, 2015), Trialability can be seen as the degree to which innovations can be experimented on within a limited basis by potential adopters or the degree to which an innovation can be experimented with, before potential adoption (Mohamad Hsbollah and Kamil, 2009), (Etsebeth, no date). In terms of the strategy the trial-ability readiness element is important to potentially facilitate to a certain degree, a proof of concept, as well as to test, deploy and improve the implementation of AI into business processes.

Business clarity

Identified in (Intel, no date a), Business clarity element will be described as the perceived clarity, the business has with regards to artificial intelligence, in terms of expectations of this technology, requirements, goals and capability of the technology within the business.

Observable results

Identified in (Alemeye and Getahun, 2015), The observable results element will be viewed as whether the business has identified methods to show observable results when this technology (artificial intelligence) is being tested/implemented, as well as the identification of valuable observable criterion such as reduction in process time or increased efficiency. This readiness element could potentially assist facilitation to a certain degree, a proof of concept, as well as forms part of the testing, deployment and improvement of the implementation of AI into business processes.

Technology roadmaps and scenarios

Technology roadmaps and scenarios is identified as a readiness element in (Oztemel and Polat, 2006). The technology roadmaps and scenarios element encompasses all systematic attempts to understand and anticipate the potential rate, characteristics, direction and effects of technology change (Firat, Woon and Madnick, 2008). This readiness element focuses on innovation, invention, use and adoption (Firat, Woon and Madnick, 2008). The main focus of this readiness element with regards to the study will be on whether the business has identified a technology roadmap and scenario method for AI in the business.

Technology forecasting

Technology forecasting as readiness element is identified in (Oztemel and Polat, 2006). The methods used for technology forecasting are broadly classified into two categories namely, normative forecasting and exploratory forecasting (Cheng, Chen and Chen, 2008). The exploratory forecasting encompasses the forecasting of future based on past and present data, which includes growth curves, case study method and Delphi method (Cheng, Chen and Chen, 2008). The normative forecasting encompasses predicting the technological performance, which is dependent on future needs. It thus forecasts available capabilities on the assumption that needs will be met (Cheng, Chen and Chen, 2008). Some types of methods associated with normative forecasting are relevance trees and scenario writing method (Cheng, Chen and Chen, 2008). The focus of this readiness element will be on whether the business being evaluated has identified technology forecasting methods for AI with regards to the business.

Agile delivery

The agile methodology includes an adaptive and capable team that responds to changes in requirement, welcomes changing requirements even late in the development stage, working software/products is delivered frequently and focuses on the principle of customer satisfaction through providing continuous and rapid delivery of small and useful software (Balaji and Murugaiyan, 2012). Two characteristics keywords of an agile approach are interactive and incremental (Kendall and Kendall, no date). Adoption of agile methods in a distributed delivery environment poses a large challenge (Sharma, Kaulgud and Duraisamy, 2016). The five stages of the agile modelling development process can be seen in the figure below.

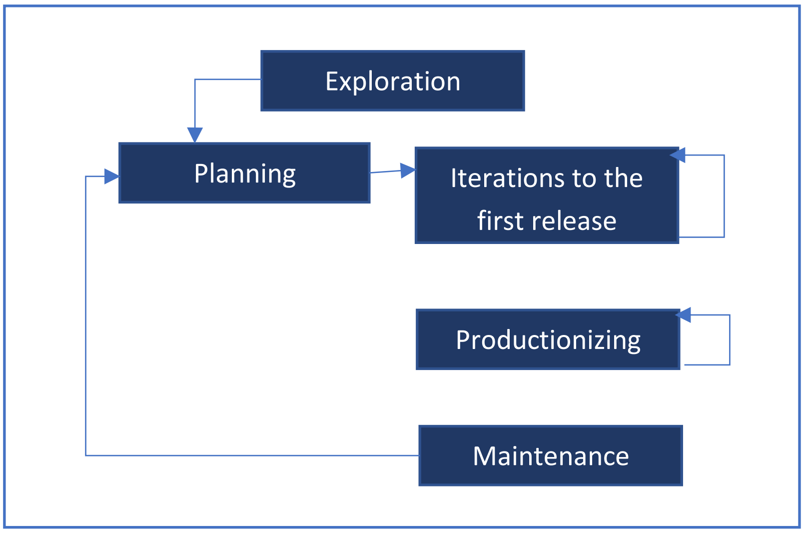

Figure 54. Agile delivery process

Here is an example of an agile delivery software development process, which integrates AI activities. With regards to an agile delivery there are some criteria that has been identified for determining if a team is agile with the focus on software development are, Active stakeholder participation, regression testing, self-organization and disciplined, continuous improvement and regular delivery of working software (Ambler, 2010).

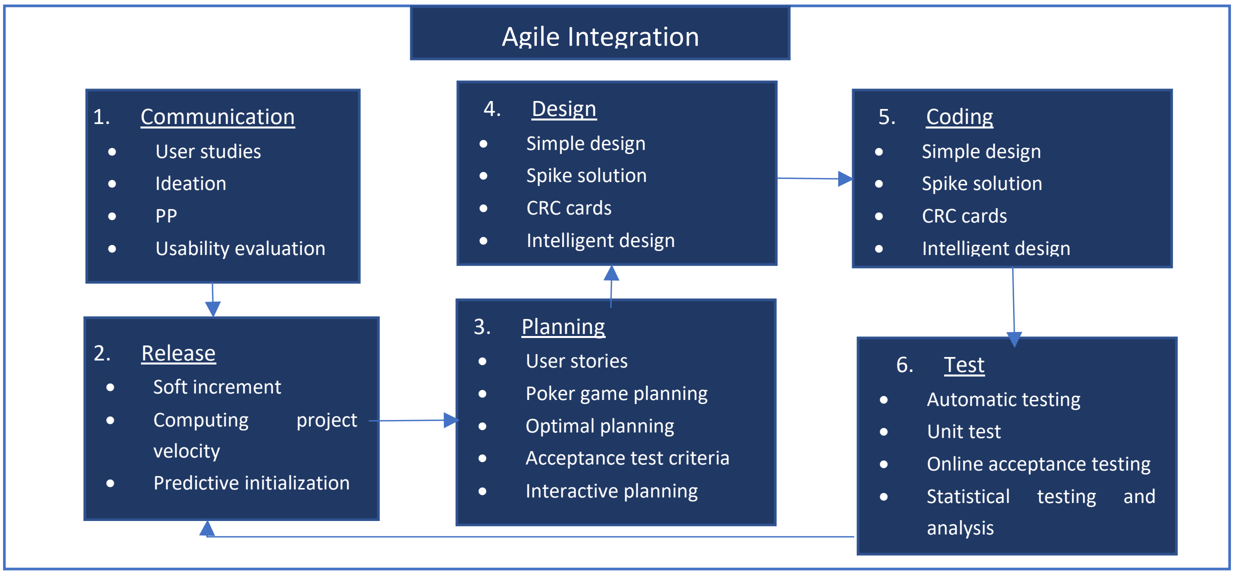

Figure 55. Agile delivery software development process (Kulkarni and Padmanabham, 2017)

Some advantages with regards to the agile method are, the ability to respond to changing requirements of the project, as well as the continuous inputs and communication from the client, which removes the risk of guesswork between the customer and the development teams. A disadvantage of the agile method is that it is difficult to judge the efforts and time required for the project with regards to software development life cycle (Balaji and Murugaiyan, 2012). With regards to this readiness element, the main focus is that the business needs to develop an agile strategy with regards to AI development, implementation and operation.

5.7 Knowledge and information management

Knowledge and information management has been identified as one of the readiness dimensions in the previous sections as an important aspect with regards to determinisation of a business' readiness for new technologies, such as AI. To better understand this dimension and elements. One first needs to look at the key activities associated knowledge management. These activities are knowledge generation, which entails the creation of new ideas and patterns, knowledge codification and knowledge transfer, which ensures the exchanging of knowledge between individuals and departments (Bouthillier and Shearer, 2002). Information management focuses primarily on performing plans and activities that are required to control an organization's records and information (Bouthillier and Shearer, 2002).

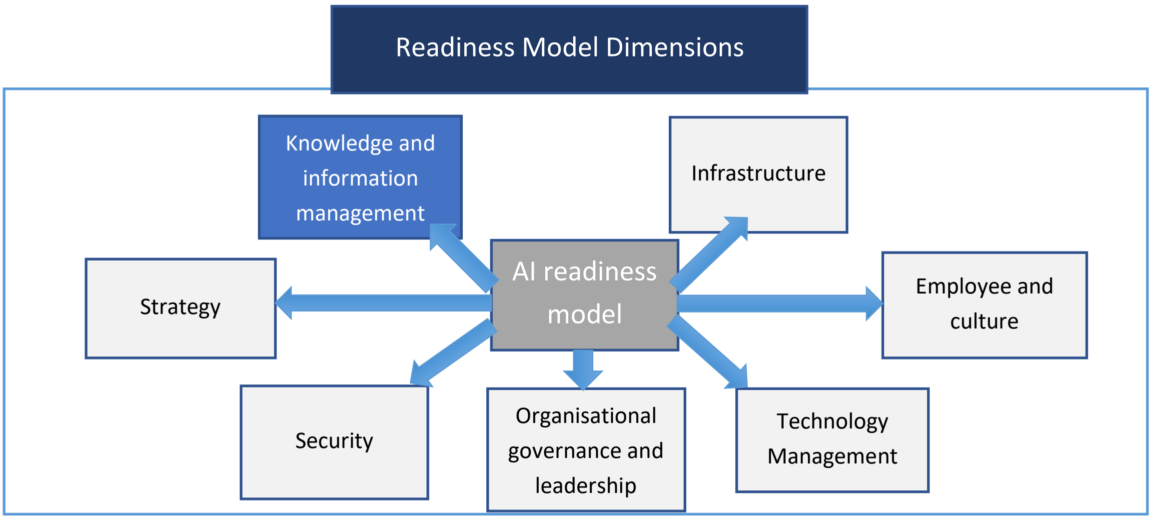

Figure 56. Knowledge and information management readiness dimension identification

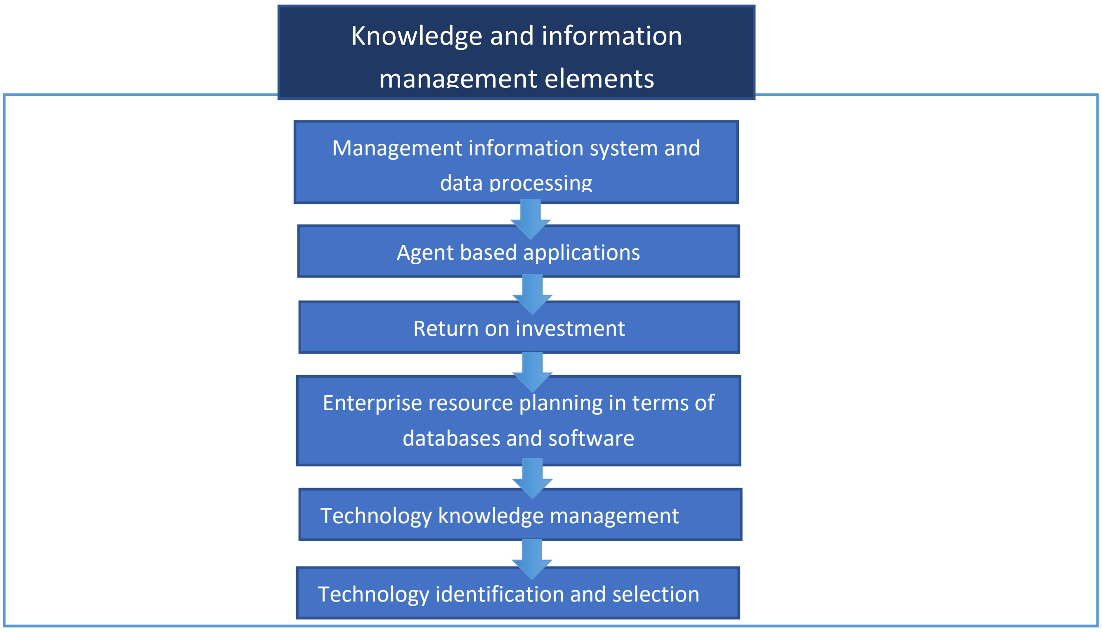

Figure 57. Knowledge and information management elements

Management information system and data processing

Management information system and data processing as a readiness element is identified in (Oztemel and Polat, 2006). Authors in the field of system analysis, data management and software evaluation, indicate that information system knowledge is vital in terms of developing successful and competitive firms, adding business value, providing applicable products and service to customers and managing global corporations (Laudon and Laudon, 1968). Management information systems is defined as, "the study of [computer based] information systems in business and management" (Laudon and Laudon, 1968). Information systems literacy is vital for managers which are confronted with major challenges in the business, these challenges are:

- Information system investments
- Strategic business
- Globalization
- Information infrastructure
- Ethics and security

With regards to this study the focus of this readiness model will be that the business being evaluated should have initiated the development of management structures for information systems and data processing.

Agent based applications

Agent based modelling as a readiness element was identified in (Oztemel and Polat, 2006). Agent based modelling or simulation is a largely used application, it is a computational and modelling framework that simulates processes that are dynamic in nature and involves autonomous agents (Macal and North, 2015). Agent-based simulation is mostly used to model in individual decision-making, social and organizational behaviours (Macal and North, 2015). This readiness element could potentially facilitate to a certain degree, an early proof of concept, with regards to the implementation of AI into business processes. The focus of this readiness element will be to identify the level of agent-based modelling that has been conducted with the aim of identifying the impacts of AI in business processes.

Return on investment

Return on investment as a readiness element was identified in (Oztemel and Polat, 2006). Return on investment is a used performance measurement and evaluation metric (Botchkarev and Andru, 2011). It is a powerful tool for providing decision support on software acquisitions and other projects (Botchkarev and Andru, 2011). The initial estimations identify the value that this technology could generate with respect to its investment, form an important part leveraging support and resources towards the implementation, integration and management of AI.

Enterprise resource planning in terms of databases and software

Enterprise resource planning in terms of databases and software as a readiness element was identified in (Oztemel and Polat, 2006). ERP is comprised of integrated sets of software, which can be used to manage and integrate all the business functions within an organisation (Shehab *et al.*, 2004). These packages have the ability to facilitate the flow of information between processes in the supply chain (Shehab *et al.*, 2004). ERP provides companies with the ability to integrate various departmental information (Shehab *et al.*, 2004). The main focus of this readiness model is the initiation of enterprise resource planning of databases and software for AI.

Technology knowledge management

Technology knowledge management as a readiness element was identified in (Oztemel and Polat, 2006). Interest in knowledge management comes from the transition into knowledge economy, where knowledge is seen as a principle source of sustainable competitive advantage and value creation (Alavi and Leidner, 2001). An adequate knowledge management strategy should contain an articulated business strategy, description of knowledge-based business issues, inventory of available knowledge resources. Knowledge management strategy includes the analysis of recommended knowledge leverage points, describing the uses of the obtained knowledge above, as well as identifying knowledge management projects with the focus on maximizing ROI and business value (Dalkir, 2013). With regards to the information above the main focus of this readiness element is initiation of technology management knowledge strategies for the implementation of AI.

Technology identification and selection

Technology identification and selection as a readiness element was identified in (Oztemel and Polat, 2006). In terms of technology identification and selection, the three main aspects that were identified are technology compatibility, system impact of the technology and the maturity/readiness of the technology (Kirby, 2001). Technology compatibility consists of identifying the appropriate technologies needed, which are physically compatible and established in a technology compatibility matrix. The impact of a technology is probabilistic in nature, due to various contributing factors. This is largely influenced if the technology is not fully maturity (Kirby, 2001). With regards to the information above the main focus of this readiness element is the level of analysis the business has conducted with regards to the compatibility of the technology, its impact on the system and the maturity of the AI that the business is targeting/aiming to implement.

5.8 Integration of concepts into an index

This section serves as the conclusion of this chapter by providing an illustrative table of the developed readiness dimensions, elements and variables, which can be seen below. Through the high-level development of the readiness dimensions the following index was developed to provide an overall view of the readiness elements and variables within the following readiness dimensions:

- Employee and culture
- Technology management
- Organizational governance and leadership
- Strategy
- Infrastructure
- Knowledge and information
- Security.

Table 28. Initial developed readiness index

d	Readiness dimension	i	Readiness element	n	Readiness variables	$X_{d,i,n}$
1	Employee and culture	1	Job security	1	Employees' perception on job security with regards to AI	$X_{1,1,1}$
		2	Perceived usefulness	2	Employees' perception on the usefulness of AI	$X_{1,2,2}$
		3	Perceived ease of use	3	Employees' perception with regards to ease of use of AI	$X_{1,3,3}$

		4	Compatibility with existing values and practices	4	Compatibility of AI with business values and practices	$X_{1,4,4}$
		5	Benefits	5	Employees' perception on the benefits regarding AI	$X_{1,5,5}$
		6	Business acceptance	6	Perceived business acceptance of AI	$X_{1,6,6}$
		7	Skills and expertise	7	Perceived current skills and expertise capability to implement and manage AI	$X_{1,7,7}$
		8	Collaboration	8	Willingness of employee collaboration with regards to AI	$X_{1,8,8}$
		9	Certainty	9	Willingness of employee collaboration with regards to AI	$X_{1,9,9}$
2	Technology management	10	Technological categorization and planning	10	Technological categorization and planning progress for AI	$X_{2,10,10}$
		11	Technology requirement handling	11	Identification of technology requirement management structures	$X_{2,11,11}$
		12	Technological investment and capital management	12	Allocation of Investment and capital management for AI	$X_{2,12,12}$
		13	Cost management	13	Identification of cost management structures for AI	$X_{2,13,13}$
		14	Technological competitors' analysis	14	Identification of cost management structures for AI	$X_{2,14,14}$
		15	Cloud resources	15	Identification and selection of cloud computing models, such as infrastructure as a service, Platform as a service or software as a service	$X_{2,15,15}$
				16	Identification and satisfaction of requirements regarding Cloud computing models	$X_{2,15,16}$
				17	Identification and selection of cloud	$X_{2,15,17}$

					computing deployment models, such as cloud, hybrid and on-premises models	
				18	Identification and satisfaction of requirements regarding cloud computing deployment models	$X_{2,15,18}$
		16	Network connectivity	19	Identification of required network connectivity within business for AI	$X_{2,16,19}$
		17	Technology risk management	20	Assign responsibilities and roles for managing risks involving AI	$X_{2,17,20}$
				21	Prioritisation and identification of information system assets	$X_{2,17,21}$
				22	Implementation of practices and controls to mitigate risks	$X_{2,17,22}$
				23	The identification and assessment of the probability, as well as the impact of current and emerging threats, vulnerabilities and risks	$X_{2,17,23}$
				24	Implementation of periodic improvement/update and monitoring of risk assessment to include changes in systems, as well as operating/environmental conditions that could affect the risk analysis	$X_{2,17,24}$
		18	Quality management	25	Identification and selection of quality management structures for AI	$X_{2,18,25}$
		19	Human resource planning	26	Documentation of data regarding the short to long	$X_{2,19,26}$

					term goals of the AI project	
				27	Effort regarding the identification of the types of resources, people and competencies that will be required	$X_{2,19,27}$
3	Organisational governance and leadership	20	Executive support	28	Executive support regarding AI	$X_{3,20,28}$
		21	Budget	29	Allocation of a budget for AI	$X_{3,21,29}$
		22	Business opportunity	30	Identification of applicable business opportunities for AI	$X_{3,22,30}$
		23	Strategic leadership	31	Identification of strategic leadership, which comply with the activities and characteristics of a strategic leader	$X_{3,23,31}$
		24	Business cases	32	Identification of business cases for AI	$X_{3,24,32}$
4	Strategy	25	Trial-ability	33	Capability to conduct a certain amount of testing (test data)	$X_{4,25,33}$
		26	Business clarity	34	Perceived business clarity with regards to AI	$X_{4,26,34}$
		27	Observable results	35	Identification of methods and criteria involved with generating observable results during testing/implementation of AI	$X_{4,27,35}$
		28	Technology roadmaps and scenarios	36	Identification of technology roadmaps and scenarios regarding AI	$X_{4,28,36}$
		29	Technology prospect/forecasting	37	Identification of technology forecasting methods for AI	$X_{4,29,37}$
		30	Agile delivery	38	Development of the agile strategy with regards to AI	$X_{4,30,38}$
5	Infrastructure	31	Technologic sustainability and position map	39	Development of the technology sustainability and position map for AI	$X_{5,31,39}$

		32	Communication networks	40	Identification of communication networks involved with operation of AI	$X_{5,32,40}$
		33	Information networks	41	Identification of information networks involved with implementation, operation and management of AI	$X_{5,33,41}$
		34	Services	42	Identification and mapping of services that will incorporate AI	$X_{5,34,42}$
		35	Infrastructure platform	43	Identification of required infrastructure in terms of cloud resources, as well required additional infrastructure sections	$X_{5,35,43}$
6	Knowledge and information management	36	Management information system and data processing	44	Initiation of the development of management structures for information systems and data processing	$X_{6,36,44}$
		37	Agent based applications	45	Conducting agent-based simulations or modelling to indicate possible impacts of AI on business processes	$X_{6,37,45}$
		38	Return on investment	46	Calculations of the return on investment for AI	$X_{6,38,46}$
		39	Enterprise resource planning in terms of databases and software	47	Identification of enterprise resource planning (databases and software) for AI	$X_{6,39,47}$
		40	Technology knowledge management	48	Initiation of technology knowledge management strategies for AI	$X_{6,40,48}$
		41	Technology identification and selection	49	Analysis of technology compatibility, system impact of AI and the maturity of the AI	$X_{6,41,49}$
7	Security	42	Cyber Security	50	Identification and development of management of cyber	$X_{7,42,50}$

					security with regards to Artificial intelligence	

Chapter 6: Constructing the readiness model

The aim of this section is to develop the fundamental workings/operations of AI readiness model. This will substantiate the development and deployment of the AI readiness model. The main focus of this model is the development of the weighting's methods, as well as the weightings for the readiness model, as well as the development of the validation process. This will complete the requirements for readiness model to be able to conduct a case study. The current methodology steps can be seen in the figure below, followed by the chapter objectives.

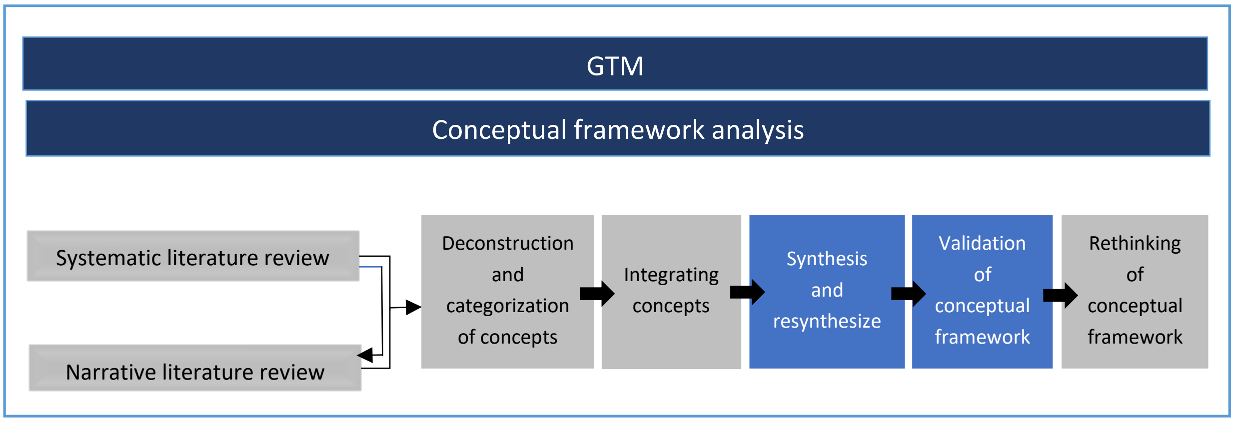

Figure 58. Study methodology process step

Chapter 6 Objectives	Identify the process of operations of the AI readiness model
	Develop the weighting methods for readiness model
	Develop validation process for the study
	Determine the weightings for the readiness model

This section is focused on developing and indicating the operations of the developed AI readiness model. As the sections focuses on operations and readying the readiness model, the methodology for operations in the model is included, such as the weighting, IPA and readiness evaluation methods. The process followed towards setting up and using the AI readiness model can be seen in the figure below. The process is divided into two main parts namely the pre-requisites and operations. The pre-requisite section focuses on the model being continuously improved and updated to ensure the model provides the more applicable and accurate results through incorporated validation steps that can be seen in the following section.

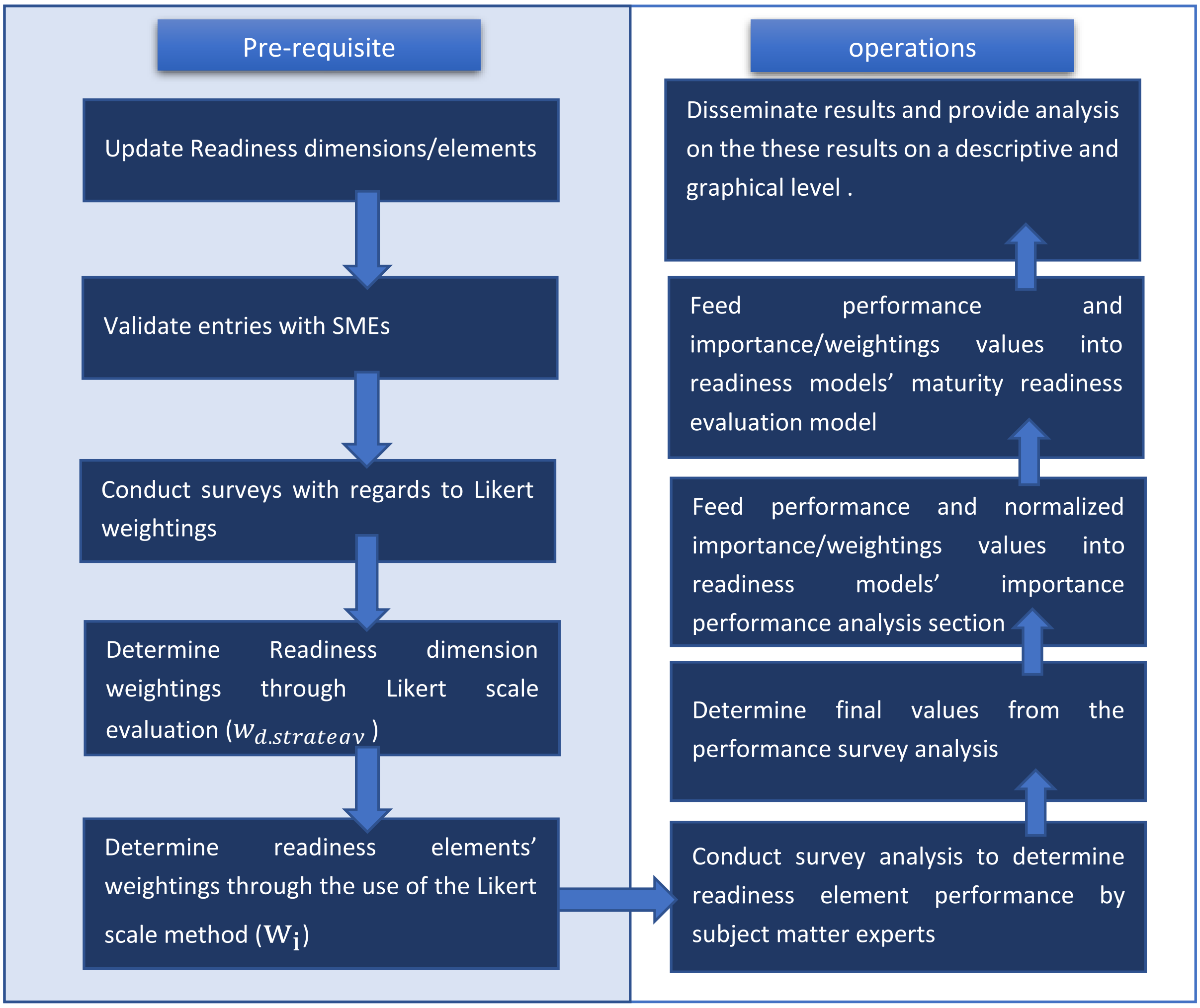

Figure 59. Basic process of operations with regards to the readiness model

6.1 Validation of readiness model, dimensions and elements

The readiness dimensions and elements are validated through the use of surveys with subject matter experts with regards to technology management, technology enterprise readiness and AI/robotic process automation. The validation process is divided into three phases namely the pre-requisite, validation focused area and the operation of the readiness model phases. The pre-requisite phase includes the completion of the systematized and narrative literature reviews, as well as the development of the readiness dimensions, elements and variables. The validation focused area highlights where in the process of development to operation of the readiness model, validation steps are incorporated. The first validation step uses SME inputs to validate the incorporation of readiness elements in the model, the second large validation step is the determination of the perceived validity, applicability and effectivity of the readiness model from SME's, as well as the Case study interviewees. The validation process can be seen in the figure below.

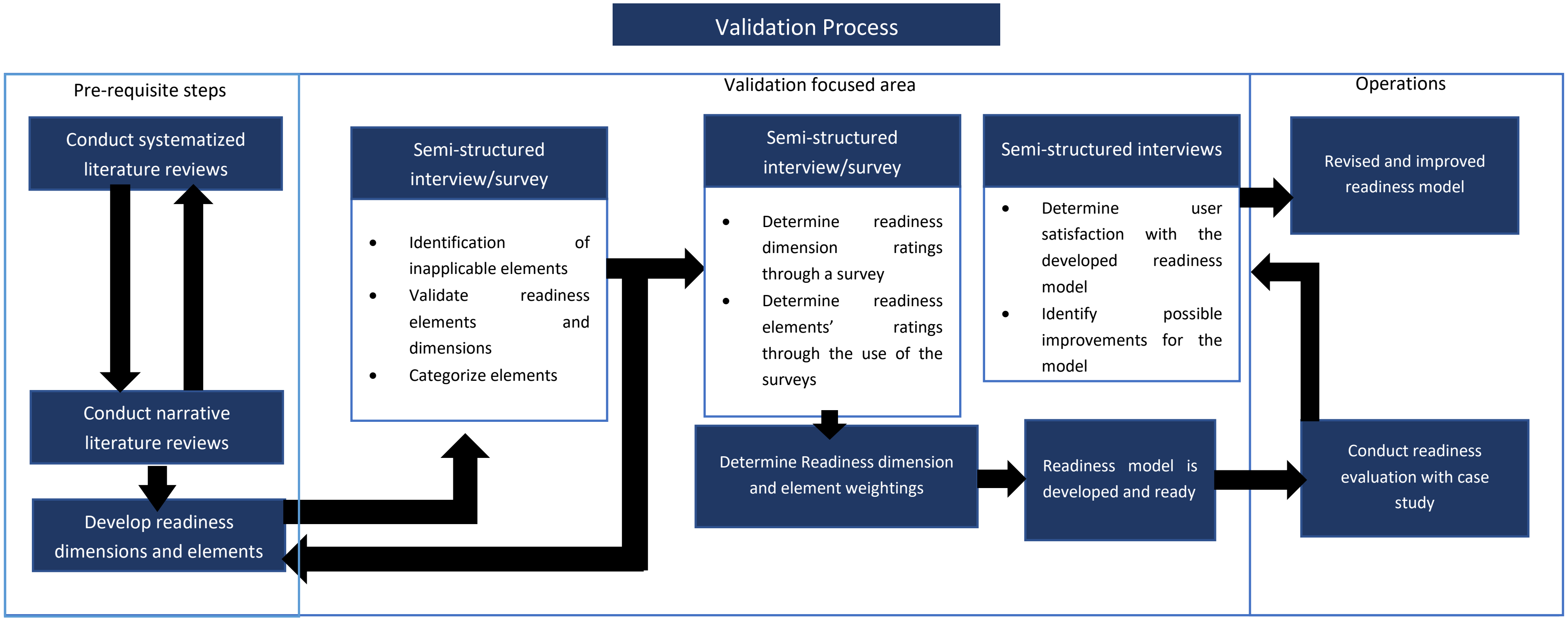

Figure 60. Validation process

6.2 Calculation of the weightings

The calculation of the weightings will be done through the use of the AHP and the Likert scale methods. The inclusion/development of the readiness models' weightings can be seen the figure below. The Likert scale will be used to determine the weightings for the readiness models' dimensions, whereas the AHP method will be used to develop the readiness elements' weightings. Interviews and surveys are conducted with subject matter experts to determine the weightings of each. The subject matter experts are chosen following the criteria below:

- Have basic to expert knowledge and experience in the field of robotic process automation/ artificial intelligence
- Have experience in dealing with the implementation/integration of new technologies into business
- Have experience in the management of digital project and technologies such as artificial intelligence or robotic process automation.

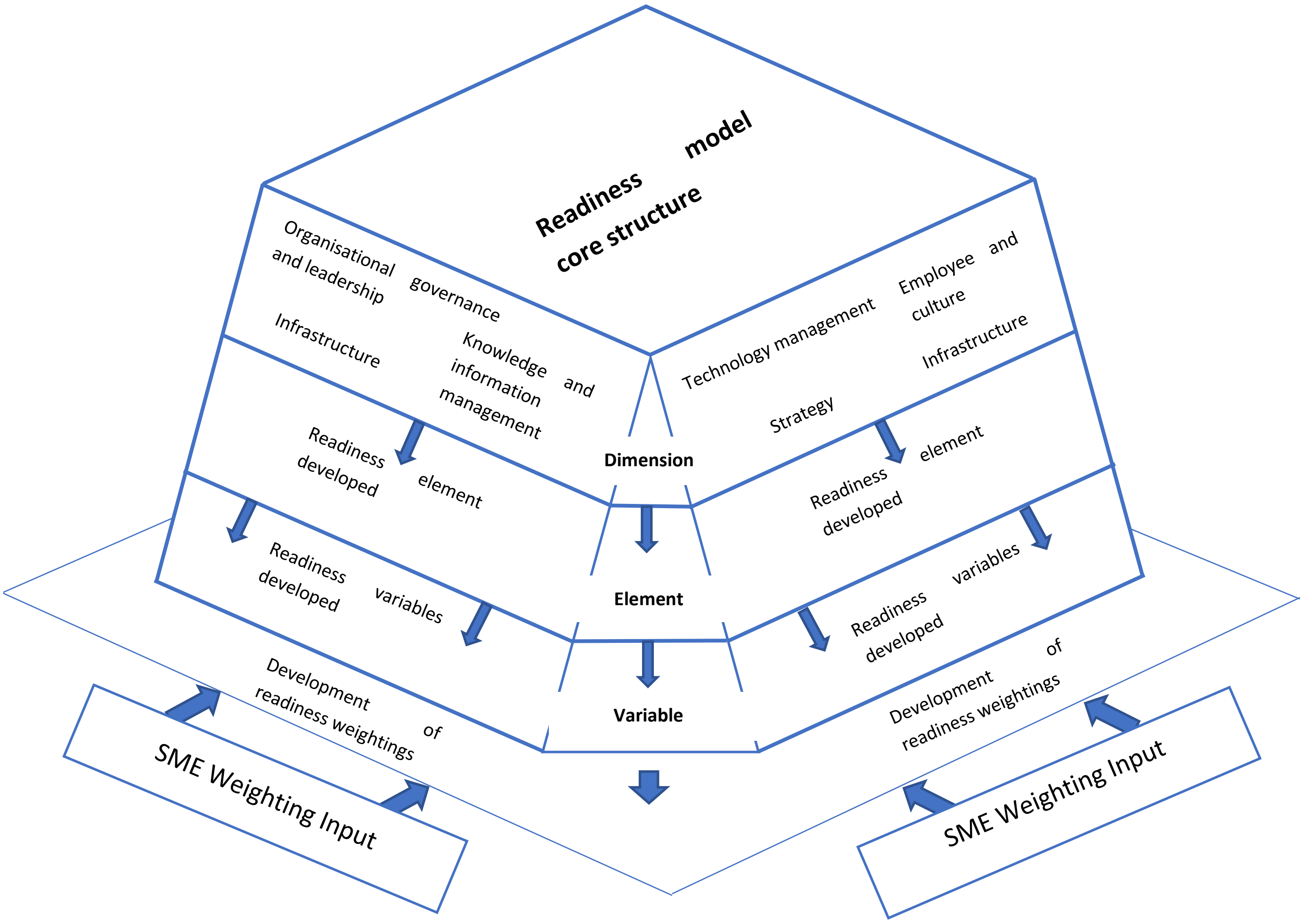

Figure 61. Illustration of weighting development

6.2.1 Weighting methods for readiness dimensions/indicators

This section explains the methods for developing the weightings used for the readiness model in terms of operations, as well as determining SME satisfaction with regards to the model. The different weighting methods are further discussed in the following sections.

Likert scale

The original Likert scale encompasses a set of indicators/items which describes/influences a hypothetical or real situation in the study. The participants are given statements /indicators/items, which they have to indicate their level of agreement ranging from strong disagreement to strong agreement (Joshi *et al.*, 2015). The differentiation between symmetric vs asymmetric Likert scales are that symmetrical Likert scale can be identified when the position of neutrality is exactly in between two extremes of the level of agreement (Joshi *et al.*, 2015). An asymmetrical Likert scale provides less options on one side of the neutrality (average), in comparison to the other side (Joshi *et al.*, 2015). Some advantages of the Likert scale are (Nemoto and Beglar, 2014):

- Gathering information from large groups of respondents is relatively fast.
- Provides reliable person ability estimates.
- Data can be compared, combined and contrasted with the use of qualitative methods, such as interviews or participant observation.
- Validity of interpretations made from the data can be established.

Challenges associated with the Likert scale are that the seven-point Likert items suffer from style bias, the Likert items are less stable in comparison to binary answer formats and the seven-point Likert items take longer to complete in comparison to binary answer formats (Joshi *et al.*, 2015). The Likert scale will be used to determine the weightings of the readiness model dimensions with respect to AI implementation and integration. The importance scale for the Likert scale can be seen in the table below.

Table 29. Likert importance scale

Rating	Description
1	Not important
2	somewhat important
3	Moderately important
4	Quite important
5	Very important

The ratings (r) of every readiness dimension with regards to TRM (technology readiness model) dimensions namely, strategy, operations and tactical was rated, for every respondent (s – number of respondent), where (d) denotes the readiness dimensions. The formulas are seen below.

$$r_{d,s,strategy} = likert\ scale\ rating\ ranging\ from\ 1\ to\ 5$$

$$r_{d,s,operations} = likert\ scale\ rating\ ranging\ from\ 1\ to\ 5$$

$$r_{d,s,tactical} = likert\ scale\ rating\ ranging\ from\ 1\ to\ 5$$

To develop the weightings (w) of the readiness dimensions with regards to the TRM dimensions, the individual ratings are divided by the sum of the ratings in that specific readiness dimension with regards to the TRM dimensions. The formulas to complete this can be seen below.

$$r_{d,s,total} = r_{d,s,strategy} + r_{d,s,operations} + r_{d,s,tactical}$$

$$w_{d,strategy} = (\sum_{1}^{s}(r_{d,s,strategy}/r_{d,s,total}))/s$$

$$w_{d,operations} = (\sum_{1}^{s}(r_{d,s,operations}/r_{d,s,total}))/s$$

$$w_{d,tactical} = (\sum_{1}^{s}(r_{d,s,tactical}/r_{d,s,total}))/s$$

The overall weightings of the readiness dimensions with regards to the readiness model is determined through dividing the total rating score ($r_{d,s,total}$) by the sum total rating scores across every readiness dimension. Thereafter the average across the number of respondent (s) is calculated. The formula can be seen below.

$$w_d = (\sum_{1}^{s}(\frac{r_{d,s,total}}{\sum_{1}^{d}(r_{d,s,total})}))/s$$

The use of the Likert scale to determine the weightings of readiness elements, within each readiness dimension will make use of a larger rating scale, so as to provide wider selection of ratings for subject matter experts, as well as providing a more in-depth understanding of the gathered data. The scale can be seen in the table below. The readiness elements will be weighed against each other for that specific dimension.

Table 30. Likert scale for readiness elements

Intensity of importance (P_{ij})	Definition
1	Very low importance
2	Low importance
3	Low - moderate importance
4	Moderate importance
5	Moderate - high importance
6	High importance
7	Very high importance

The ratings can be shown below as:

$$r_{d,i,s} = likert\ scale\ rating\ ranging\ from\ 1\ to\ 7$$

The formula for determining the weighting of the readiness element is determined as:

$$r_{d,i,s,total} = \sum_1^i (r_{d,i,s})$$

$$w_{d,i} = (\sum_1^s (r_{d,i,s}/r_{d,i,s,total}))/s$$

<u>AHP (Analytical hierarchy process) method</u>

The Analytic hierarchy process (AHP) was developed by Saaty (Saaty, 1980), and provides a framework for solving a range of multi-criterion decision problems based on the relative importance/priorities assigned to each criteria's role towards obtaining the objective (Handfield *et al.*, 2002).

The main advantage of the AHP method is the ability to work with intangibles present in the process of decision making (Javanbarg *et al.*, 2012). Some advantages are: 1) it's the only MCDM model that can measure the consistency in the decision maker's judgement 2) it's easy to understand and handles qualitative and quantitative data 4) can assist decision makers in organizing critical aspects in a hierarchical structure (Javanbarg *et al.*, 2012). An important disadvantages/limitation of the method is that decision makers could find it extremely difficult to express strength of preference and to provide exact pairwise comparison judgements (Javanbarg *et al.*, 2012).

In terms of decision making towards generating priorities for the AHP method, the following steps are required (Saaty, 2008):

- Define the knowledge sought and the problem identified.
- Structure the decision hierarchy from the top. The goal of the decision forms parts here. From there the objectives from a broad perspective are identified, which is succeeded by intermediate (elements dependant criteria) and lowest levels (set of alternatives).
- Develop pairwise comparison matrices. Every element in the upper level is compared to elements in the lower level.
- The priorities in the level immediately below are weighed by the priorities, which are calculated through comparisons in the current level. This process is done for every element. Every element in the level below, is given its weighted value and its overall global priority is determined. This process of weighing and adding until the final priorities of the alternatives (lowest level) is determined.

The expert knowledge is thus obtained through the pairwise comparisons and omits the need for extensive qualitative data gathering and analysis (Saaty, 1980). The number of comparisons (c) increases exponentially with the number of criteria (n). This is shown in the equation below.

$$C = 0.5\, n^2 - 0.5n$$

This means that if the developed set of criteria is very large it could pose a problem if manual pairwise evaluation must be done in a survey or interview by subject matter experts. The exponential growth of the comparisons can be seen in the figure below.

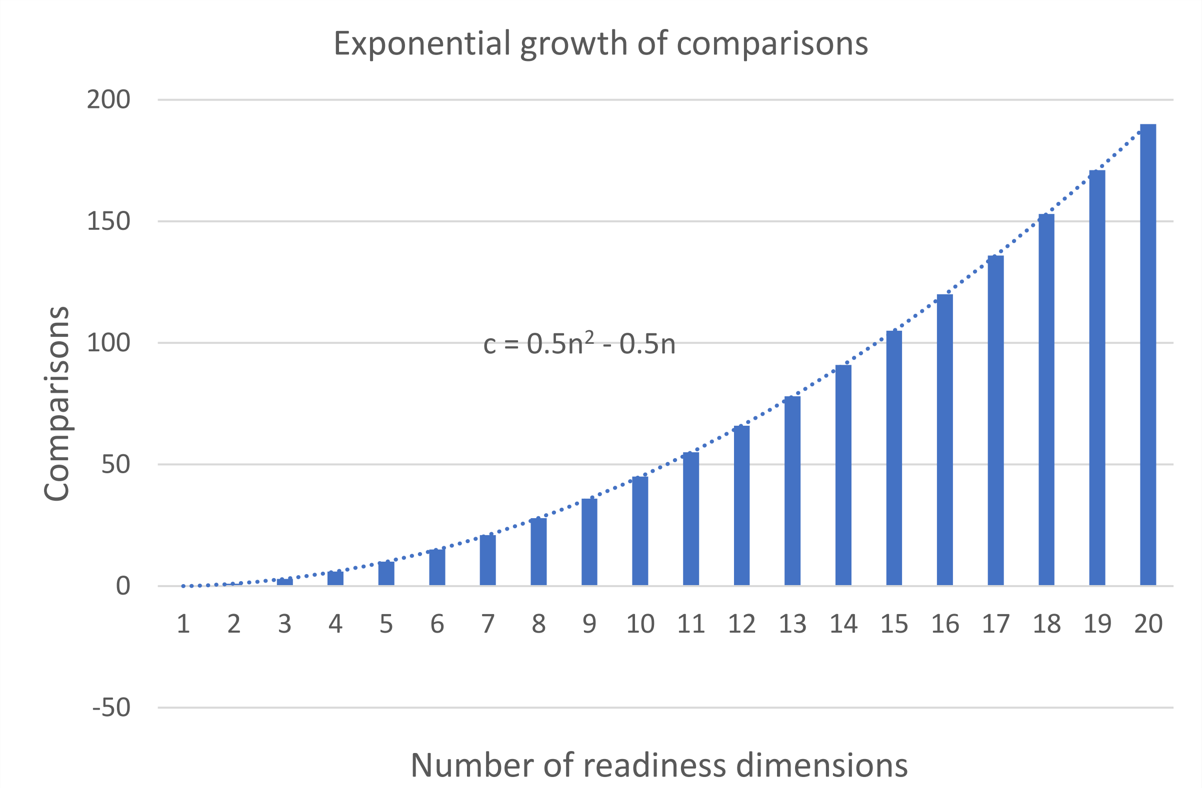

Figure 62. Exponential growth in pair wise comparisons

The pairwise comparisons form an $n \ x \ n$ matrix (P). The entries are denoted P_{ij}, The entries encompass the importance of i^{th} element with respect to the j^{th} element. When P_{ij} > 1, the i^{th} element/criterion has a higher importance than the j^{th} element/criterion. The opposite holds true when P_{ij} < 1. When P_{ij} = 1, then the elements are equally important. Once the whole number is given to the appropriate position, the reciprocal is entered in the transpose position. It is important to note that:

$$P_{ij} \bullet P_{ji} = 1$$

The scale of importance or absolute numbers can be seen in the table below. The table shows the number, definition and explanation of each intensity of importance.

Table 31. The scale of absolute numbers (Saaty, 2008)

Intensity of importance (P_{ij})	Definition	Explanation
1	Equal importance	The two criterion/elements are equally important.
2	Slight importance	Through experience and judgement, one criterion is viewed as slightly more important.
3	Moderate importance	

4	Moderate plus importance	Through experience and judgement, one criterion is viewed as largely more important.
5	Strong importance	
6	Strong plus importance	The element is very strongly favoured over the other through demonstration in practice.
7	Very strong importance	
8	Very strong plus importance	The element/criterion most favoured over the other criterion.
9	Extreme importance	

After the pairwise matrix (P) is built, the matrix will be normalized the to form P_{norm}. This is done by making the sum of entries in each column equal to 1. Each entry of the matrix P_{norm} will be calculated as, with (m) being the number of rows:

$$\overline{P_{ij}} = \frac{P_{ij}}{\sum_{l=1}^{m} P_{lj}}$$

The weighting criteria vector (w) (this an m-dimensional column vector), is developed by the determining the average of the entries in each row of P_{norm}. The formula can be seen as where (d) denotes the dimension:

$$w_{d,i} = \frac{\sum_{l=1}^{m} \overline{P_{il}}}{m}$$

Checking consistency

The process of pairwise comparisons, has the possibility to produce inconsistencies. The AHP has an effective method for checking the consistency of the evaluations conducted by the decision maker, in terms of building the matrices. To determine the consistency index (**CI**) of the matrices, one requires the λ_{max} of the matrices. The process steps that will be followed are shown here.

1. The sum of each column in (P) is determined, this provides entries (s_{1}, s_{2}, s_{3}.......) for the (S) vector.

$$s_i = \sum_{l=1}^{m} \overline{P_{il}}$$

2. The λ_{max} determined using the formula (dot product) below.

$$\lambda_{max} = S.W$$

3. The consistency index can be determined with the use of the calculated λ_{max}. If the experts' entries are perfectly consistent then the calculated CI will be equal to zero. Small inconsistencies which result in the CR to be smaller than 0.1 can be tolerated and is considered reliable.

$$CR = CI/RI < 0.1$$

RI is the random index. These values are generated when the consistency index is completely random. The values of RI for small problems ($m \leq 10$) are shown in the table below.

Table 32. Values of RI corresponding to m number of criteria

m	2	3	4	5	6	7	8	9	10
RI	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.51

These steps were implemented in the interviews with experts to ensure that their entries are consistent and reliable, thus providing more accurate weightings for the readiness model.

6.2.2 Subject matter expert surveys

The surveys were conducted through physical administration or using online survey tools. The surveys section related towards calculation of the weightings are done through a Likert scale assessment and pair-wise matrix comparisons for the AHP method. The format/examples of the surveys can be seen in Appendix H. The next section presents the results from the survey.

6.2.3 Result from the surveys

Some basic information on the SME's is shown to further support the validation of the framework. The criteria involved in the selection of individuals was mainly focused around individuals that were currently in industry with connections to cognitive/automation (artificial intelligence or robotics) projects. These individuals were required to have knowledge regarding AI projects and training, as well as have experience with the implementation of cognitive/digital or robotic process automation projects. Short descriptions of the SME profiles are shown in Table 33.

Table 33. SME information

	SME data	Description
Respondent 1	Profession	Research and development of cognitive automation/AI
	Expertise in terms of AI/robotics and technology integration	Technical management and infrastructure
Respondent 2	Profession	Head of cognitive automation
	Expertise in terms of AI/robotics and technology integration	Robotic process automation and simple AI tools capability integration
Respondent 3	Profession	Technical operations manager – cognitive automation
	Expertise in terms of AI/robotics and technology integration	Technical operations manager in robotics
Respondent 4	Profession	Intelligent automation analyst
	Expertise in terms of AI/robotics and technology integration	Research and development in cognitive automation
Respondent 5	Profession	Head of governance & COE, with regards to robotic process automation
	Expertise in terms of AI/robotics and technology integration	Technical experience, deploy software and solutions to business problems
Respondent 6	Profession	Head of cognitive automation
	Expertise in terms of AI/robotics and technology integration	New to the field, current focus and interests are various application of AI in business
Respondent 7	Profession	Analyst programmer
	Expertise in terms of AI/robotics and technology integration	Data analysis and reporting

The individuals where asked what type of frameworks or methods they were using to determine the business; readiness or maturity within their fields with regards to artificial intelligence implementation/integration. It was provided that the responses can be summarized/short. These are the results:

Table 34. SME information with regards to AI readiness frameworks

Respondent number	Feedback
Respondent 1	No current framework is used. Progress is largely influenced through enterprise agreements with strategic vendors (co-creation, leveraging their technology offerings and roadmaps)
Respondent 2	Within a limited capacity: • Delivery of business benefits vs plan • Use of technologies • Basic due diligence against competitors' products • Construction of research and developmental areas
Respondent 3	No current measure of readiness, however business processes are selected on a very specific set of criteria.
Respondent 4	/
Respondent 5	No formal framework is being used; strategy is developed.
Respondent 6	Develop willingness/evidence of AI tools to apply to the aspects of financial services. For example, measurement could be positive, where the technology has been purchased to unlock AI's potential, but the business has not adopted the technology in a meaningful way would be negating that. Determine demand into AI unit vs needing to hunt for work.
Respondent 7	Interviews are conducted with SME's and key stakeholders, as well as comparisons with other business areas and/or competitors.

As can be seen – no integrated formal readiness tool seems to be used by the SMEs at present. The table above further indicates the value technology readiness frameworks with a focus on AI could bring for businesses at the start of their AI journeys. This further adds to solving the large problem of integrating AI projects into existing business structures and processes.

The validity of the identified readiness dimensions and elements are further discussed, through the identification of whether each readiness element is relevant or irrelevant with regards to the topic. The results can be seen in the table below, with symbols ✓ = relevant, × = irrelevant.

Table 35. Relevant vs irrelevant readiness elements

Readiness dimension and element		Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Respondent 6	Respondent 7
Technology management	Human resource planning	✓	✓	✓	✓	✓	✓	✓
	Quality Management	✓	✓	×	✓	✓	✓	✓
	Technology Risk Management	✓	✓	✓	✓	✓	✓	✓
	Network Connectivity	✓	✓	✓	✓	✓	✓	✓
	Cloud resources	✓	✓	✓	✓	✓	×	×
	Technological competitors' analysis	✓	✓	✓	✓	✓	✓	✓
	Cost management	✓	✓	✓	✓	✓	✓	✓
	Technological investment and capital management	✓	✓	✓	✓	✓	✓	✓
	Technology requirement handling	✓	✓	✓	✓	✓	✓	✓
	Technological categorization and planning	✓	✓	×	✓	✓	×	✓
Employee and culture	Job Security	✓	✓	×	✓	×	×	×
	Perceived usefulness	✓	✓	✓	✓	✓	×	✓
	Perceived ease of use	✓	✓	✓	✓	✓	✓	✓
	Compatibility with existing values and practices	✓	✓	✓	✓	✓	×	✓
	Benefits	✓	✓	✓	✓	✓	✓	✓
	Business Acceptance	✓	✓	✓	✓	✓	✓	✓
	Skills and expertise	✓	✓	✓	✓	✓	✓	×
	Collaboration	✓	✓	✓	✓	✓	×	×
	Certainty	✓	✓	✓	✓	×	✓	×
Organizational governance	Executive support	✓	✓	✓	✓	✓	✓	✓
	Budget	✓	✓	✓	✓	✓	✓	✓

and leadership dimension	Business opportunity	✓	✓	✓	✓	✓	✓	✓
	Strategic leadership	✓	✓	✓	✓	✓	✓	✓
	Business cases	×	✓	×	✓	✓	✓	✓
Strategy	Trial-ability	✓	✓	×	✓	✓	✓	×
	Business clarity	×	✓	✓	✓	✓	×	✓
	Observable results	✓	✓	✓	✓	✓	✓	✓
	Technology roadmaps and scenarios	✓	✓	✓	✓	✓	✓	×
	Technology prospect/forecasting	✓	✓	✓	✓	✓	✓	×
	Agile delivery	✓	✓	✓	✓	✓	✓	×
Infrastructure	Technologic sustainability and position map	✓	✓	✓	✓	✓	✓	×
	Communication networks	✓	✓	✓	✓	✓	×	✓
	Information networks	✓	✓	✓	✓	✓	✓	✓
	Services	✓	✓	✓	✓	✓	✓	✓
	Infrastructure platform	✓	✓	✓	✓	✓	✓	✓
Knowledge and information management	Management information system and data processing	✓	✓	✓	✓	✓	✓	✓
	Agent based applications	✓	✓	✓	✓	✓	✓	×
	Return on investment	×	✓	×	✓	✓	✓	✓
	Enterprise resource planning in terms of databases and software	✓	✓	✓	✓	✓	✓	✓
	Technology knowledge management	✓	✓	✓	✓	✓	✓	✓
	Technology identification and selection	✓	✓	✓	✓	✓	✓	✓

The decision on the inclusion/exclusion of an element was based on the unanimous decisions of the chosen SMEs. The results of the table can be seen in the figure below. It was decided that all the identified readiness elements would be included in the study. The figure below provides some insight in terms of what elements were seen as relevant by all the SMEs.

Table 36. Readiness dimension colour index for relevant count figure

Readiness Dimension	Legend colour
Employee and Culture	
Technology Management	
Organisational governance and leadership	
strategy	
Infrastructure	
Knowledge and information management	
Security	

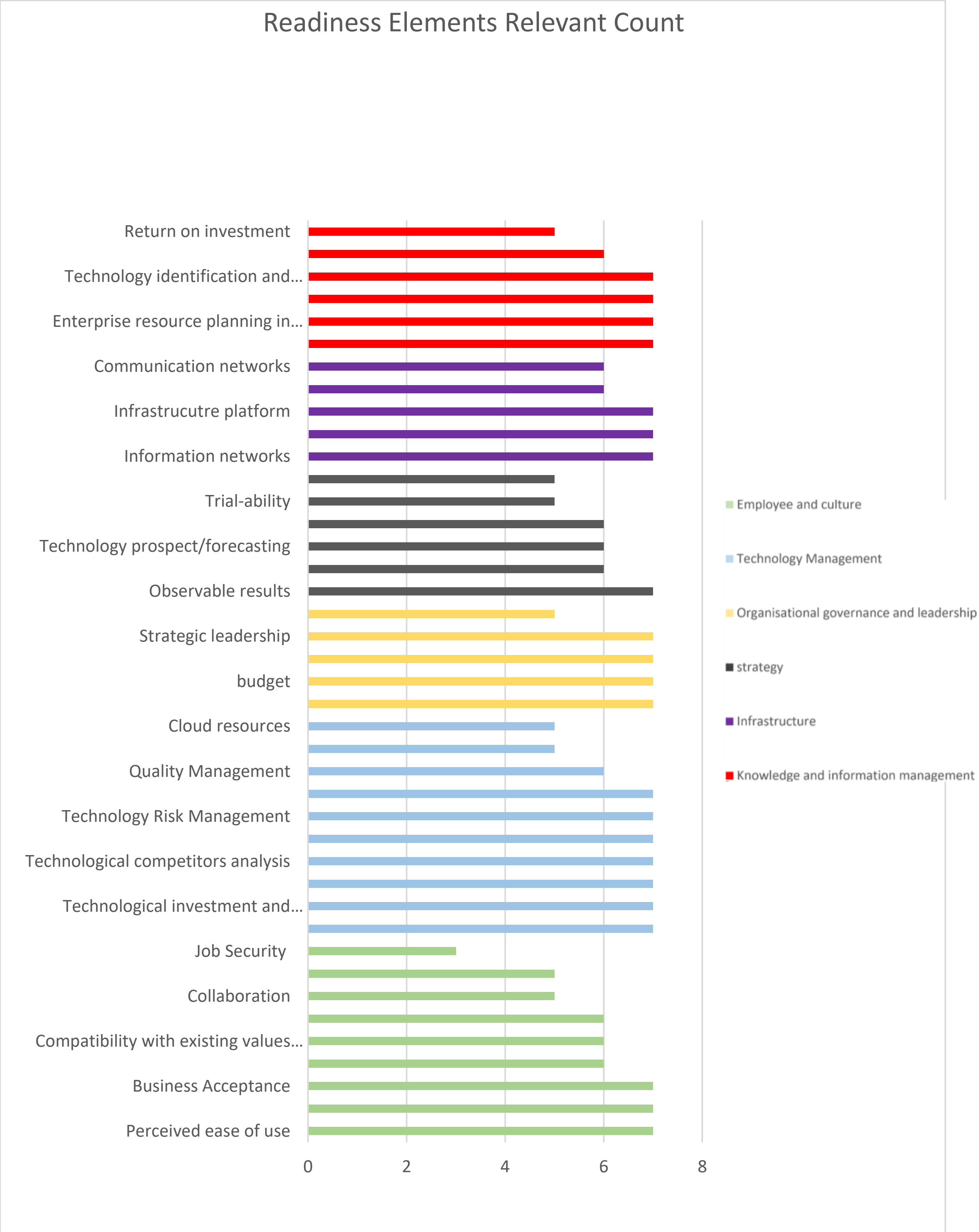

Figure 63. Readiness Element Relevant Count

The SMEs were furthermore asked to identify whether the readiness elements, which were identified are positioned in the correct dimension. In order for the element to change dimensions the majority of SMEs need to agree. The results can be seen in the table below.

Table 37. Dimension change requests

Readiness dimension and element		Number of dimension change requests (change ≥ 4)
Technology management	Human resource planning	3
	Quality Management	0
	Technology Risk Management	0
	Network Connectivity	1
	Cloud resources	0
	Technological competitors' analysis	0
	Cost management	0
	Technological investment and capital management	1
	Technology requirement handling	0
	Technological categorization and planning	1
Employee and culture	Job Security	0
	Perceived usefulness	0
	Perceived ease of use	0
	Compatibility with existing values and practices	0
	Benefits	0
	Business Acceptance	0
	Skills and expertise	0
	Collaboration	0
	Certainty	0
Organizational governance and leadership dimension	Executive support	0
	Budget	0
	Business opportunity	0
	Strategic leadership	0
	Business cases	0
Strategy	Trial-ability	0
	Business clarity	0
	Observable results	0
	Technology roadmaps and scenarios	0
	Technology prospect/forecasting	0
	Agile delivery	0
Infrastructure	Technologic sustainability and position map	0
	Communication networks	0
	Information networks	0

	Services	0
	Infrastructure platform	0
Knowledge and information management	Management information system and data processing	0
	Agent based applications	0
	Return on investment	0
	Enterprise resource planning in terms of databases and software	0
	Technology knowledge management	0
	Technology identification and selection	0

From the results above it is determined no dimensional changes of the readiness elements had to be made. Thus, the readiness model index developed was retained as first developed. The development of the weightings of dimensions was the next step in this section. The focus is to develop the weightings for the overall dimensions (W_d) and thereafter the readiness elements ($W_{d,i}$), which reside within each readiness dimension.

The weightings of the readiness dimensions are determined through the use of the Likert scale (1 to 5 ratings). The dimensions are weighted with regards to strategy, operations and tactics. From this the overall weightings are determined. The results of the readiness dimension weightings can be seen in the tables below.

Table 38. Strategy weightings of readiness dimensions

Readiness dimension(d)	Respondent 1 Weighting	Respondent 2 Weighting	Respondent 3 Weighting	Respondent 4 Weighting	Respondent 5 Weighting	Respondent 6 Weighting	Respondent 7 Weighting	W_d Average	Std.Dev
Employee and Culture	0.3333	0.3333	0.4	0.3076	0.3846	0.375	0.3636	0.3568	0.0305
Technology Management	0.4166	0.3333	0.3571	0.2727	0.4166	0.4166	0.4	0.3733	0.0511
Organisational governance and leadership	0.4166	0.3333	0.4545	0.3333	0.4166	0.4545	0.3076	0.3881	0.0572
Strategy	0.5555	0.3846	0.3571	0.3333				0.4076	0.0872
Infrastructure	0.4166	0.3571	0.3636	0.2307	0.4444	0.3076	0.4444	0.3664	0.0723
Knowledge and information management	0.4166	0.3333	0.4444	0.2307	0.36363	0.3846	0.4166	0.3700	0.0664
Security	0.4166	0.3333	0.2857	0.3333	0.3846	0.2727	0.4166	0.3490	0.0544

Table 39. Operational weightings of readiness dimensions

Readiness dimension(d)	Respondent 1 Weighting	Respondent 2 Weighting	Respondent 3 Weighting	Respondent 4 Weighting	Respondent 5 Weighting	Respondent 6 Weighting	Respondent 7 Weighting	W_d Average	Std.Dev
Employee and Culture	0.4166	0.3333	0.4	0.3846	0.3076	0.375	0.2727	0.3557	0.0486
Technology Management	0.25	0.3333	0.3571	0.4545	0.25	0.0.25	0.3	0.3135	0.0701
Organisational governance and leadership	0.3333	0.3333	0.3636	0.3333	0.25	0.1818	0.3076	0.3004	0.0584
Strategy	0.3333	0.2307	0.2857	0.3333				0.2957	0.0422
Infrastructure	0.25	0.2857	0.3636	0.3846	0.2222	0.3846	0.2222	0.3018	0.0688
Knowledge and information management	0.3333	0.3333	0.3333	0.3846	0.2727	0.3076	0.25	0.3164	0.0412
Security	0.3333	0.3333	0.3571	0.3333	0.3076	0.3636	0.3333	0.337	0.017

Table 40. Tactical weightings of readiness dimensions

Readiness dimension(d)	Respondent 1 Weighting	Respondent 2 Weighting	Respondent 3 Weighting	Respondent 4 Weighting	Respondent 5 Weighting	Respondent 6 Weighting	Respondent 7 Weighting	W_d Average	Std.Dev
Employee and Culture	0.25	0.3333	0.2	0.3076	0.3076	0.25	0.3636	0.2874	0.0523
Technology Management	0.3333	0.3333	0.2857	0.2727	0.3333	0.3333	0.3	0.3131	0.0244
Organisational governance and leadership	0.25	0.3333	0.1818	0.3333	0.3333	0.3636	0.3846	0.3114	0.0655
Strategy	0.1111	0.3846	0.3571	0.3333				0.2965	0.1085
Infrastructure	0.3333	0.3571	0.2727	0.3846	0.3333	0.3076	0.3333	0.3317	0.0327
Knowledge and information management	0.25	0.3333	0.2222	0.3846	0.3636	0.3076	0.3333	0.3135	0.0544
Security	0.25	0.3333	0.3571	0.3333	0.3076	0.3636	0.25	0.3135	0.0435

From these readiness dimension weightings' tables, the overall readiness dimensional weighting is determined. This can be seen in the formulas below.

$$r_{d,s,total} = r_{d,s,strategy} + r_{d,s,operations} + r_{d,s,tactical}$$

$$w_{d,strategy} = (\sum_{1}^{s}(r_{d,s,strategy}/r_{d,s,total}))/s$$

$$w_{d,operations} = (\sum_{1}^{s}(r_{d,s,operations}/r_{d,s,total}))/s$$

$$w_{d,tactical} = (\sum_{1}^{s}(r_{d,s,tactical}/r_{d,s,total}))/s$$

The overall weightings of the readiness dimensions with regards to the readiness model is determined through dividing the total rating score ($r_{d,s,total}$) by the sum total rating scores across every readiness dimension. Thereafter the average across the number of respondent (s) is calculated. The formula can be seen below.

$$w_d = (\sum_{1}^{s}(\frac{r_{d,s,total}}{\sum_{1(}^{d} r_{d,s,total})}))/s$$

Table 41. Overall readiness dimension weightings

Readiness dimension(d)	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Respondent 6	Respondent 7	W_d Average	Std.Dev
	Weighting	Weighting	Weighting	Weighting	Weighting	Weighting	Weighting		
Employee and Culture	0.1481	0.147	0.1204	0.1511	0.1566	0.0930	0.1279	0.1349	0.0209
Technology Management	0.1481	0.147	0.1686	0.1279	0.1445	0.1395	0.1162	0.1417	0.0153
Organisational governance and leadership	0.1481	0.147	0.1325	0.1395	0.1445	0.1279	0.1511	0.1415	0.0079
Strategy	0.1111	0.1274	0.1686	0.1744				0.1454	0.0268
Infrastructure	0.1481	0.1372	0.1325	0.1511	0.1084	0.1511	0.1046	0.1333	0.0181
Knowledge and information management	0.1481	0.147	0.1084	0.1511	0.1325	0.1511	0.1395	0.1397	0.0142
Security	0.14815	0.14706	0.16868	0.10465	0.15663	0.12701	0.13953	0.1418	0.01923

A graphical illustration of the results can be seen in the figure below, which shows the average weighting vs the weightings provided by the SMEs. It is important to note that respondents 5, 6 and 7 provided no ratings and thus no weightings with regards to strategy. The strategic dimension with regards to respondents 5, 6 and 7 was omitted from the calculations.

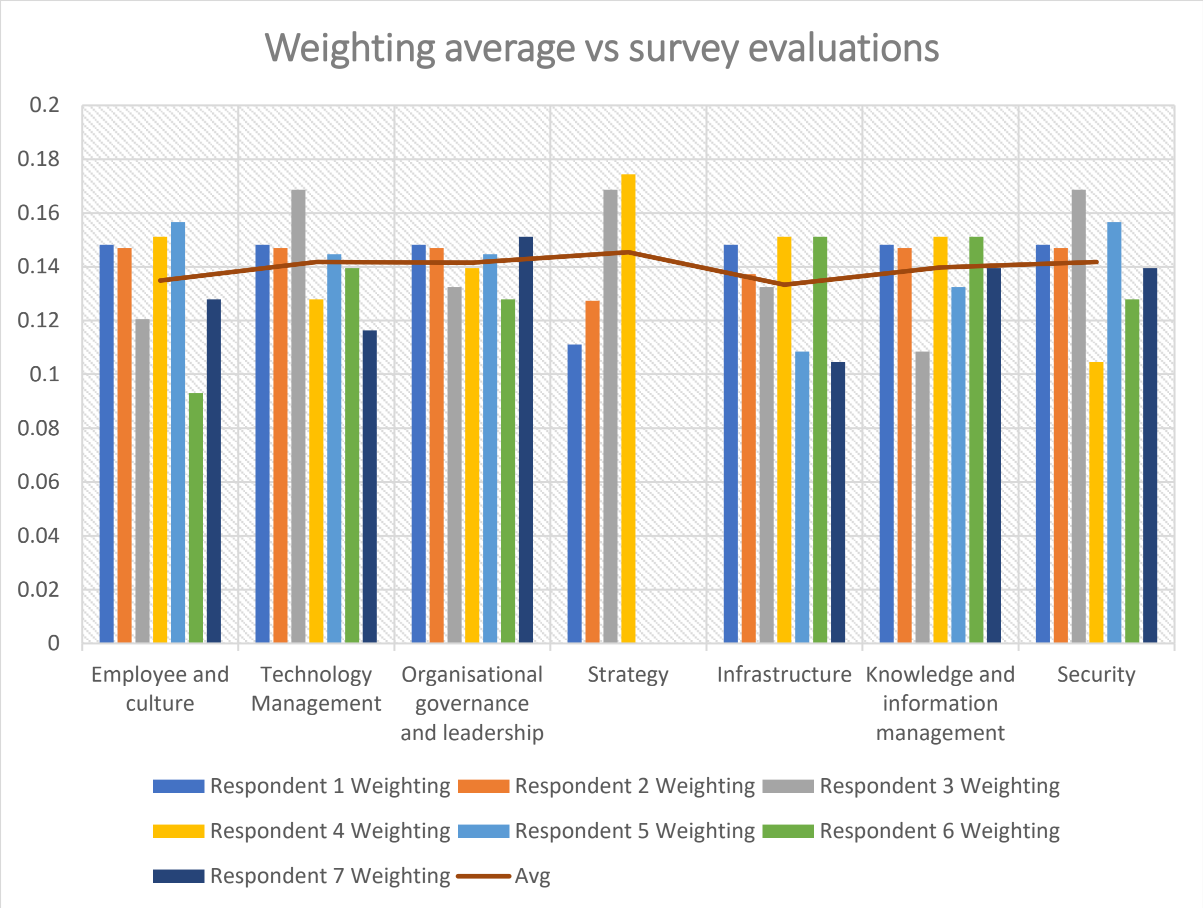

Figure 64. Weighting average vs respondent weightings

With regards to possible outliers in the data, occurrence of outliers was included in the study to include possible new insights into the importance of these weightings, as these were based on the insights of SMEs with different positions, professions, insights and experience. To identify possible outliers the following equation is used.

$$\text{Absolute percentage difference from mean} = \left(\left| W_{d,average} - W_{d,s} \right| / W_{d,average} \right) \times 100\%$$

The formula above will identify the percentage difference of each weighting with regards to the mean weighting values. This provided a quick and easy way to identify outliers, as well as trends with regards to these outliers, such as if it was caused by a specific SME respondent.

Table 42. Dimensional absolute percentage difference from mean

Readiness dimensions	Respondent 1 Weighting	Respondent 2 Weighting	Respondent 3 Weighting	Respondent 4 Weighting	Respondent 5 Weighting	Respondent 6 Weighting	Respondent 7 Weighting
Employee and culture	9.81%	9.00%	10.70%	12.04%	16.09%	31.05%	5.19%
Technology Management	4.52%	3.75%	19.00%	9.76%	2.00%	1.56%	17.96%
Organisational governance and leadership	4.65%	3.88%	6.38%	1.43%	2.13%	9.64%	6.78%
Strategy	23.59%	12.35%	16.00%	19.95%			
Infrastructure	11.11%	2.94%	0.60%	13.37%	18.68%	13.37%	21.51%
Knowledge and information management	6.03%	5.25%	22.39%	8.19%	5.15%	8.19%	0.13%
Security	4.48%	3.71%	18.95%	26.20%	10.46%	9.80%	1.60%
SMEs average difference across readiness dimensions	9.17%	5.84%	13.43%	12.99%	9.08%	12.27%	8.86%

A graphical illustration of the results can be seen in the figure below, which identified the average absolute percentage difference vs individual absolute percentage differences provided by the SMEs.

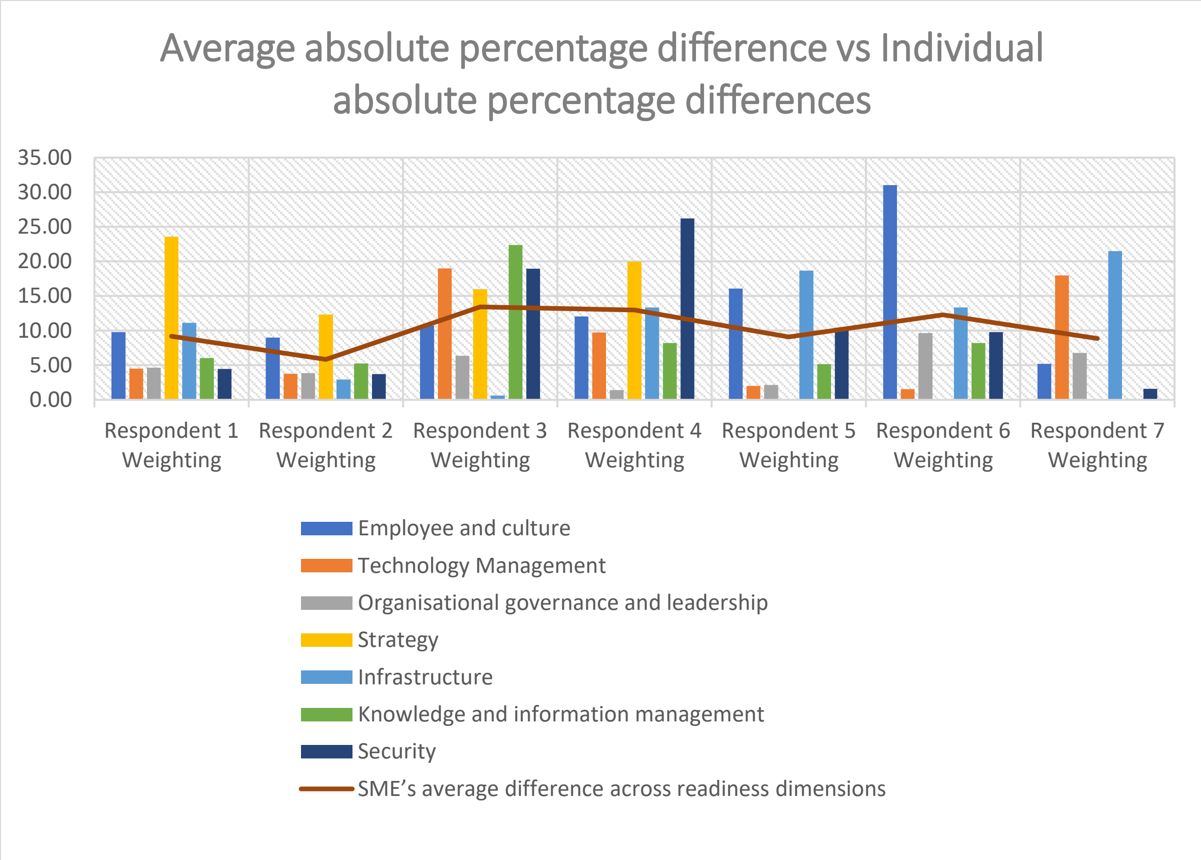

Figure 65. Average absolute percentage difference vs Individual absolute percentage differences

The next part of the weighting's evaluation contributes to determining the readiness elements' weightings with regards to each readiness dimension. The two identified methods for determining these weightings are the Likert Scale and the AHP methods. The AHP method was chosen to determine the readiness element weightings. Due to exponential growth of the pair-wise comparisons and duration of evaluations, it is decided to determine the pair wise comparisons within each of the readiness dimensions. The examples of the AHP surveys can be seen in Appendix H.

After the pairwise matrix (P) is built, the matrix will be normalized the to form P_{norm}. This is done by making the sum of entries in each column equal to 1. Each entry of the matrix P_{norm} will be calculated as, with (m) being the number of rows:

$$\overline{P_{ij}} = \frac{P_{ij}}{\sum_{l=1}^{m} P_{lj}}$$

The weighting criteria vector (w) (this an m-dimensional column vector), is developed by the determining the average of the entries in each row of P_{norm}. The formula can be seen as where (d) denotes the dimension:

$$w_{d,i} = \frac{\sum_{l=1}^{m} \overline{P_{il}}}{m}$$

The initial two SME's inputs were analysed and calculated. The results can be seen in the table below.

Table 43. Weightings calculated from AHP method

I	Readiness element	Respondent 1 Weightings ($W_{d,i}$)	Respondent 2 Weightings ($W_{d,i}$)
1	Job security	0.3132	0.2738
2	Perceived usefulness	0.2128	0.1939
3	Perceived ease of use	0.1451	0.1540
4	Compatibility with existing values and practices	0.1490	0.0924
5	Benefits	0.1027	0.1109
6	Business Acceptance	0.0737	0.0650
7	Skills and expertise	0.0517	0.0386
8	Collaboration	0.0288	0.0510
9	Certainty	0.0192	0.0199
10	Technological categorization and planning	0.0159	0.0158
11	Technology requirement handling	0.0352	0.0367
12	Technological investment and capital management	0.0398	0.038
13	Cost management	0.0572	0.0470
14	Technological competitors' analysis	0.1048	0.0795
15	Cloud Resources	0.0944	0.1089
16	Network Connectivity	0.1081	0.1108

17	Technology Risk Management	0.1381	0.1532
18	Quality Management	0.1806	0.1761
19	Human resource planning	0.2755	0.2333
20	Executive support	0.4948	0.4948
21	Budget	0.2191	0.2191
22	Business opportunity	0.126	0.1342
23	Strategic leadership	0.0830	0.1018
24	Business cases	0.0502	0.0498
25	Trial-ability	0.3749	0.4409
26	Business clarity	0.2377	0.2233
27	Observable results	0.1405	0.1407
28	Technology roadmaps and scenarios	0.1021	0.110
29	Technology prospect/forecasting	0.0514	0.0602
30	Agile delivery	0.0252	0.0237
31	Technologic sustainability and position map	0.5015	0.5015
32	Communication networks	0.2505	0.2445
33	Information networks	0.1481	0.1421
34	Services	0.0754	0.0815
35	Infrastructure platform	0.0298	0.0303
36	Management information system and data processing	0.387	0.4313
37	Agent based applications	0.2056	0.2056

38	Return on investment	0.1600	0.1719
39	Enterprise resource planning in terms of databases and software	0.1071	0.1025
40	Technology knowledge management	0.0704	0.0602
41	Technology identification and selection	0.028	0.0282

The process of pairwise comparisons, has the possibility to produce inconsistencies. The AHP has an effective method for checking the consistency of the evaluations conducted by the decision maker, in terms of building the matrices.

To determine the consistency index (CI) of the matrices, one requires the λ_{max} of the matrices. The process steps that will be followed are shown here. Samples of the matrices were retrieved and the maximum eigenvalues were also determined using built in MATLAB functions. To ensure the correct outcomes.

1. The sum of each column in P is determined, this provides entries ($s_{1,}\ s_{2,}\ s_{3\ldots\ldots}$) for the S vector.

$$s_i = \sum_{l=1}^{m} \overline{P_{il}}$$

2. The λ_{max} determined using the formula (dot product) below.

$$\lambda_{max} = S\,.\,W$$

3. The consistency index can be determined with the use of the calculated λ_{max}.

$$CI = (\lambda_{max}\text{-m})/(\text{m-1})$$

4. If the experts' entries are perfectly consistent then the calculated CI will be equal to zero. Small inconsistencies which result in the CR to be smaller than 0.1 can be tolerated and is considered reliable.

$$CR = CI/RI < 0.1$$

RI is the random index. These values are generated when the consistency index is completely random. The values of RI for small problems (m ≤ 10) are shown in the table below.

Table 44. Values of RI corresponding to m number of criteria.

m	2	3	4	5	6	7	8	9	10
RI	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.51

The results of the consistency index can be seen in the table below. The table indicates the calculated CI, as well as the CR.

Table 45. Consistency index from respondent 1 and 2

Readiness dimensions	Respondent 1		Respondent 2	
	CI	CR (< 0.1)	CI	CR (< 0.1)
Employee and culture	0.8059	0.5558	0.647	0.59
Technology Management	1.0009	0.663	0.89	0.4464
Organisational governance and leadership	0.69	0.617	0.883	0.7892
strategy	0.505	0.407	0.745	0.6004
Infrastructure	0.754	0.673	0.755	0.6743
Knowledge and information management	0.648	0.522	0.778	0.6276

Two other methods were used to determine the λ_{max}, to ensure the consistency index is calculated correctly. Besides some minor differences all of the methods pointed to a CR > 0.1 for every dimension for both respondents. This weaknesses of the AHP with regards to these studies were identified in section 2.2. Due to time limitations, as well as SME cooperation in terms of duration of assessments, as well as the time it took to change ratings to have a CR < 0.1, it was decided to use the Likert Scale to determine the readiness element weightings.

The use of the Likert scale to determine the weightings of readiness elements, within each readiness dimension will make use of a larger rating scale, so as to provide wider selection of ratings for subject matter experts, as well as providing a more in depth understanding of the gathered data. The scale can be seen in the table below. The readiness elements will be weighed against each other for that specific dimension.

Table 46. Likert scale for readiness elements

Intensity of importance (P_{ij})	Definition
1	Very Low importance
2	low importance
3	Low - moderate importance
4	Moderate importance
5	Moderate - strong importance
6	Strong importance
7	Very strong importance

The ratings can be shown below as:

$$r_{d,i,s} = likert\ scale\ rating\ ranging\ from\ 1\ to\ 7$$

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The formula for determining the weighting of the readiness element is determined as:

$$r_{d,i,s,total} = \sum_{1}^{i}(r_{d,i,s})$$

$$w_{d,i} = (\sum_{1}^{s}(r_{d,i,s}/r_{d,i,s,total}))/s$$

An example of the survey used to evaluate these elements can be seen Appendix H. The surveys were physically administered and questions regarding the readiness elements were satisfied to assist in providing the most accurate data. The results can be seen in the table below.

Table 47. Readiness element weightings

		Weightings							Combined analysis	
i	**Readiness elements (i)**	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Respondent 6	Respondent 7	Average Wd,i	Standard deviation
1	Job Security	0.1153	0.0277	0.1206	0.0925	0.0517	0.0185	0.074	0.0715	0.0376
2	Perceived usefulness	0.1153	0.0555	0.1034	0.1296	0.0862	0.0370	0.1111	0.0911	0.0312
3	Perceived ease of use	0.1346	0.0833	0.1034	0.1111	0.0689	0.0740	0.0925	0.0954	0.0212
4	Compatibility with existing values and practices	0.1153	0.1388	0.1206	0.1111	0.0862	0.0185	0.1111	0.1002	0.0363
5	Benefits	0.0769	0.1944	0.1206	0.1111	0.0862	0.074	0.1111	0.1106	0.0381
6	Business Acceptance	0.0961	0.1111	0.1206	0.1111	0.0689	0.074	0.074	0.0937	0.0197
7	Skills and expertise	0.1346	0.1666	0.1034	0.1111	0.0689	0.0925	0.074	0.1073	0.0318
8	Collaboration	0.1346	0.1944	0.1206	0.1296	0.0689	0.037	0.074	0.1084	0.0485
9	Certainty	0.0769	0.0277	0.0862	0.09259	0.0517	0.0555	0.037	0.0611	0.0229
10	Technological categorization and planning	0.0754	0.125	0.0892	0.0862	0.0714	0.0517	0.0689	0.0811	0.0212

11	Technology requirement handling	0.1132	0.1041	0.1071	0.1034	0.1071	0.1034	0.0862	0.1035	0.0077
12	Technological investment and capital management	0.0943	0.1458	0.125	0.1034	0.0892	0.1034	0.0862	0.1067	0.01986
13	Cost management	0.0754	0.1041	0.1071	0.0862	0.1071	0.0689	0.1034	0.0932	0.0149
14	Technological competitors analysis	0.0566	0.0625	0.0535	0.0689	0.0535	0.0862	0.0517	0.0618	0.0114
15	Cloud resources	0.1320	0.0625	0.0892	0.1034	0.125	0.0517	0.0689	0.0904	0.0288
16	Network Connectivity	0.1132	0.125	0.125	0.1206	0.0714	0.0862	0.1206	0.1088	0.0197
17	Technology Risk Management	0.1132	0.0833	0.125	0.0862	0.0714	0.1034	0.0862	0.0955	0.0175
18	Quality Management	0.1320	0.0833	0.0714	0.1206	0.0357	0.0862	0.0862	0.0879	0.0293
19	Human resource planning	0.0943	0.1041	0.1071	0.1206	0.0535	0.0862	0.1034	0.0956	0.0198
20	Executive support	0.2592	0.2413	0.2142	0.2258	0.2142	0.2258	0.1612	0.2203	0.0282
21	Budget	0.2592	0.2068	0.25	0.2258	0.1785	0.2258	0.1935	0.2199	0.0269
22	Business opportunity	0.2222	0.2068	0.1785	0.1935	0.1785	0.1935	0.1612	0.1906	0.0186
23	Strategic leadership	0.1851	0.2068	0.25	0.1935	0.2142	0.2258	0.1612	0.2052	0.0266
24	Business cases	0.074	0.1379	0.1071	0.1612	0.1785	0.1935	0.1935	0.1494	0.0422

25	Trial-ability	0.21875	0.1304	0.1333	0.1935	0.1666	0.2258	0.0967	0.1664	0.0451
26	Business clarity	0.15625	0.2173	0.1666	0.1612	0.1333	0.0645	0.1612	0.1515	0.0425
27	Observable results	0.1875	0.1739	0.2	0.1612	0.1666	0.2258	0.1935	0.1869	0.0205
28	Technology roadmaps and scenarios	0.125	0.1739	0.1333	0.1612	0.1666	0.1935	0.1290	0.1546	0.0240
29	Technology prospect/forecasting	0.1562	0.1304	0.2	0.1612	0.1333	0.1935	0.1290	0.1576	0.0273
30	Agile delivery	0.1562	0.1739	0.1666	0.1612	0.2	0.2258	0.0967	0.1686	0.0371
31	Technologic sustainability and position map	0.1818	0.2631	0.1481	0.15625	0.222222222	0.15625	0.15625	0.1834	0.0402
32	Communication networks	0.1818	0.15789	0.1481	0.21875	0.1851	0.15625	0.1875	0.1765	0.0225
33	Information networks	0.2121	0.2105	0.2222	0.21875	0.1481	0.0625	0.1875	0.1802	0.0536
34	Services	0.2121	0.1578	0.2222	0.1875	0.1481	0.1875	0.15625	0.1816	0.0266
35	Infrastructure platform	0.2121	0.2105	0.2592	0.21875	0.1851	0.1875	0.1875	0.2086	0.0242
36	Management information system and data processing	0.2121	0.2	0.2	0.1666	0.2	0.1944	0.1666	0.1914	0.0164

37	Agent based applications	0.1515	0.1333	0.1333	0.1818	0.1333	0.1818	0.0909	0.1437	0.0294
38	Return on investment	0.1212	0.2	0.1333	0.1818	0.1666	0.1818	0.1818	0.1666	0.0266
39	Enterprise resource planning in terms of databases and software	0.2121	0.1666	0.2	0.1818	0.1666	0.2121	0.1515	0.1844	0.0223
40	Technology knowledge management	0.2121	0.1333	0.2	0.1818	0.1666	0.1515	0.1515	0.1709	0.0263
41	Technology identification and selection	0.0909	0.1666	0.1333	0.1818	0.2	0.1818	0.1515	0.1580	0.0340
42	Cyber security	1	1	1	1	1	1	1	1	0

A graphical illustration of the results can be seen in the figure below, which identifies the average weighting vs the weightings provided by the SMEs.

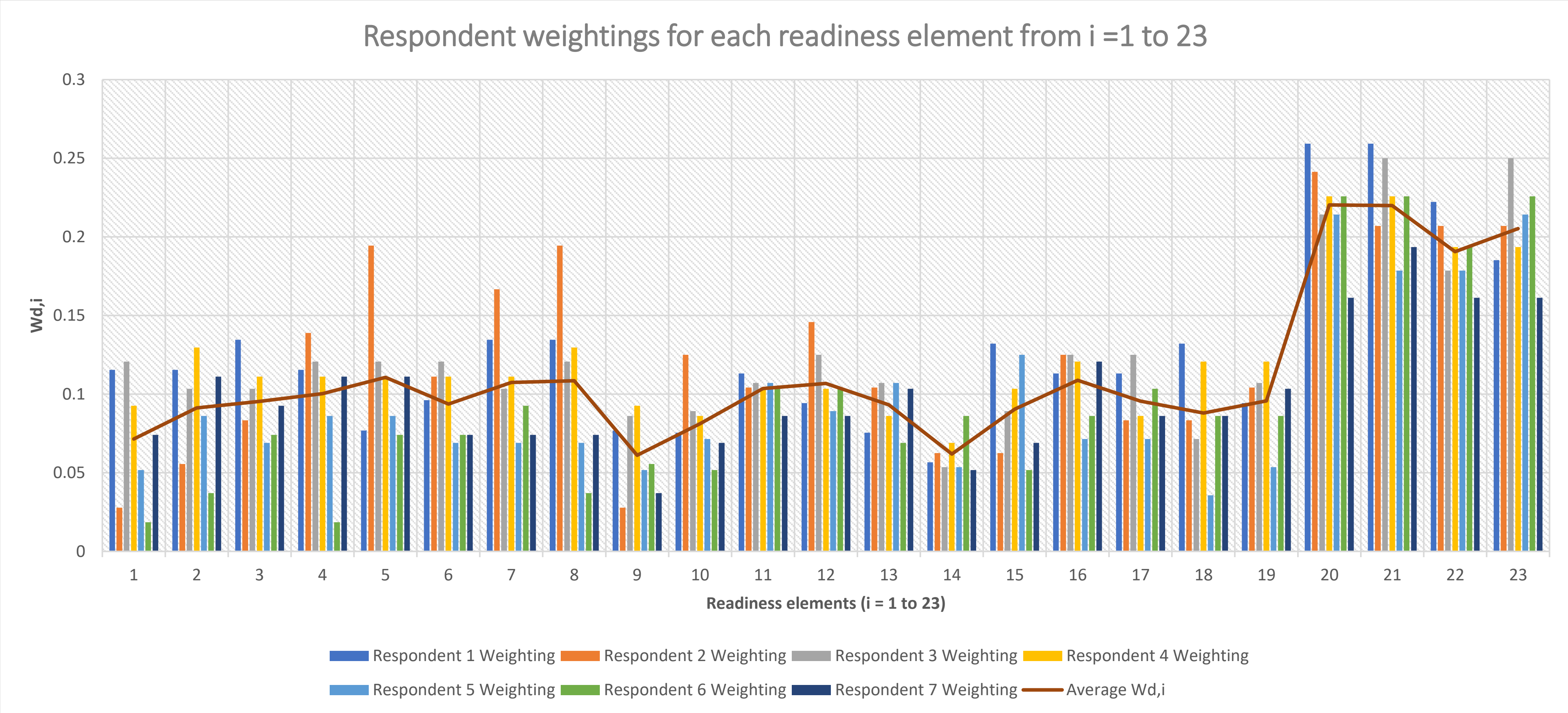

Figure 66. Weighting average vs respondent weightings for readiness elements from I= 1 to 23

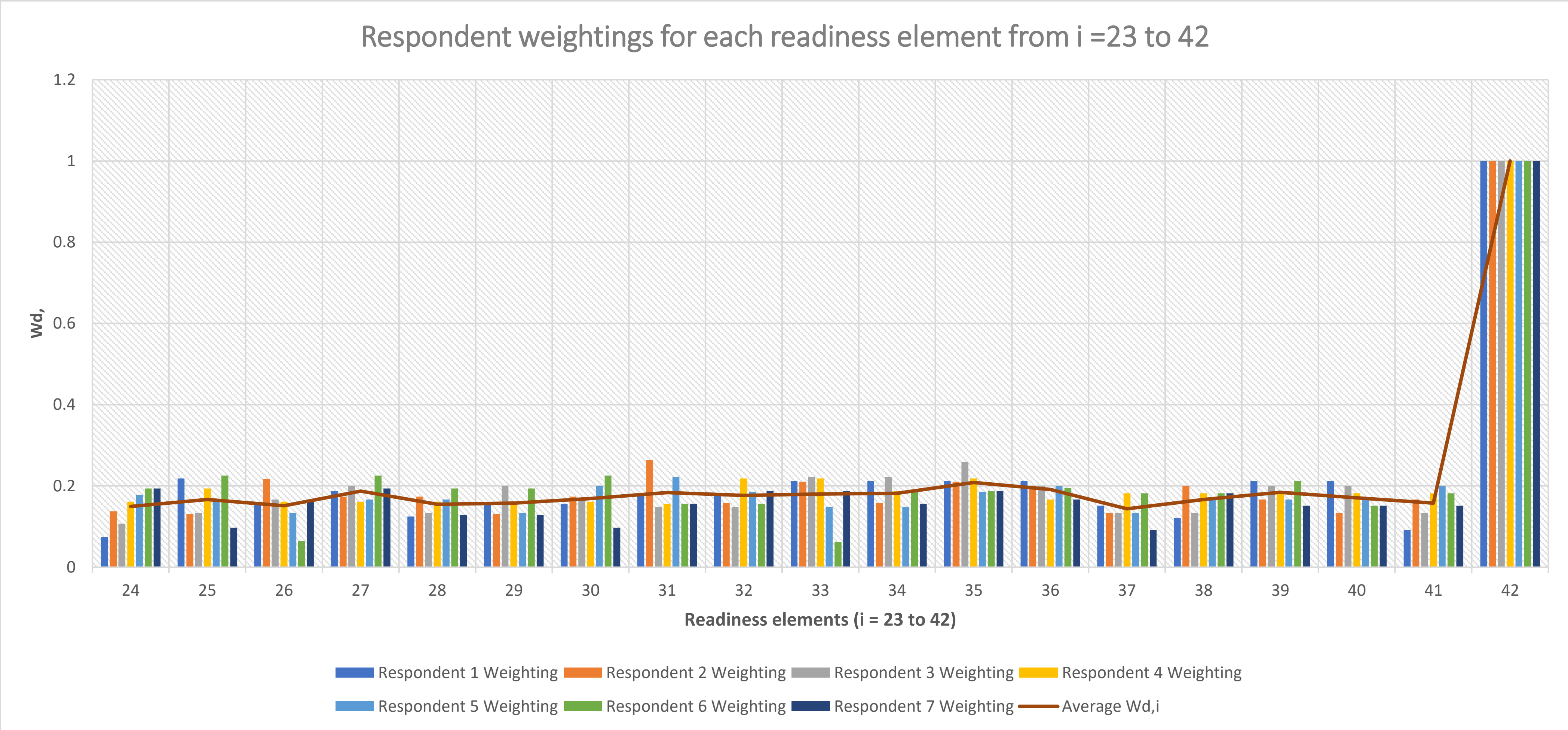

Figure 67. Weighting average vs respondent weightings for readiness elements from I= 24 to 42

Some outliers visually identified from the graph consists of respondent 2 and 6. As seen in the graph these respondents' weightings have regularly the most discrepancies with regards to the mean in comparison to the other respondents. The calculation of each SMEs average absolute percentage difference from the mean across all elements should provide more insight into the correlation of the mean of weightings and individual SMEs inputs. With regards to possible outliers in the data, occurrence of outliers is included in the study so as to include possible new insights into the importance of these weightings, as these are based on the insights of SMEs with different professions, insights and experience. To identify possible outliers the following equation is used.

$$\text{Percentage difference from mean} = \left(\left| W_{d,average} - W_{d,s} \right| / W_{d,average} \right) \times 100\%$$

This identifies the percentage difference of each weighting with regards to the mean weighting values. This should provide a quick and easy way to identify outliers, as well as trends with regards to these outliers, such as if it is caused by a specific SME respondent.

Table 48. Element absolute percentage difference from mean

i	Readiness elements (i)	Respondent 1 Weighting	Respondent 2 Weighting	Respondent 3 Weighting	Respondent 4 Weighting	Respondent 5 Weighting	Respondent 6 Weighting	Respondent 7 Weighting
1	Job Security	61.29%	61.17%	68.71%	29.43%	27.70%	74.11%	3.55%
2	Perceived usefulness	26.52%	39.08%	13.43%	42.14%	5.47%	59.39%	21.84%
3	Perceived ease of use	41.03%	12.69%	8.38%	16.41%	27.75%	22.39%	2.99%
4	Compatibility with existing values and practices	15.07%	38.51%	20.36%	10.81%	14.03%	81.53%	10.81%
5	Benefits	30.48%	75.73%	9.07%	0.42%	22.09%	33.06%	0.42%
6	Business Acceptance	2.58%	18.53%	28.75%	18.53%	26.43%	20.98%	20.98%
7	Skills and expertise	25.39%	55.25%	3.64%	3.50%	35.76%	13.75%	31.00%
8	Collaboration	24.08%	79.22%	11.24%	19.48%	36.43%	65.86%	31.72%
9	Certainty	25.86%	54.55%	41.05%	51.50%	15.37%	9.10%	39.40%
10	Technological categorization and planning	7.00%	54.03%	10.02%	6.23%	11.98%	36.26%	15.02%
11	Technology requirement handling	9.34%	0.61%	3.48%	0.09%	3.48%	0.09%	16.74%

12	Technological investment and capital management	11.66%	36.55%	17.05%	3.13%	16.39%	3.13%	19.28%
13	Cost management	19.04%	11.74%	14.93%	7.52%	14.93%	26.02%	10.97%
14	Technological competitors' analysis	8.52%	1.01%	13.42%	11.45%	13.42%	39.32%	16.41%
15	Cloud resources	46.06%	30.88%	1.26%	14.40%	38.23%	42.80%	23.73%
16	Network Connectivity	3.97%	14.80%	14.80%	10.84%	34.40%	20.83%	10.84%
17	Technology Risk Management	18.48%	12.78%	30.83%	9.78%	25.24%	8.27%	9.78%
18	Quality Management	50.17%	5.25%	18.79%	37.22%	59.39%	1.98%	1.98%
19	Human resource planning	1.37%	8.90%	12.01%	26.18%	43.99%	9.87%	8.15%
20	Executive support	17.68%	9.57%	2.73%	2.50%	2.73%	2.50%	26.79%
21	Budget	17.85%	5.95%	13.64%	2.65%	18.83%	2.65%	12.02%
22	Business opportunity	16.55%	8.51%	6.34%	1.51%	6.34%	1.51%	15.41%
23	Strategic leadership	9.79%	0.78%	21.78%	5.72%	4.38%	10.00%	21.43%
24	Business cases	50.43%	7.70%	28.31%	7.93%	19.49%	29.51%	29.51%
25	Trial-ability	31.40%	21.65%	19.91%	16.26%	0.12%	35.64%	41.87%
26	Business clarity	3.11%	43.46%	9.99%	6.44%	12.01%	57.42%	6.44%

27	Observable results	0.29%	6.98%	6.97%	13.73%	10.85%	20.78%	3.52%
28	Technology roadmaps and scenarios	19.19%	12.43%	13.80%	4.27%	7.75%	25.13%	16.58%
29	Technology prospect/forecasting	0.92%	17.29%	26.82%	2.28%	15.45%	22.73%	18.18%
30	Agile delivery	7.36%	3.11%	1.19%	4.38%	18.57%	33.87%	42.63%
31	Technologic sustainability and position map	0.89%	43.46%	19.24%	14.82%	21.14%	14.82%	14.82%
32	Communication networks	3.01%	10.54%	16.07%	23.93%	4.92%	11.48%	6.23%
33	Information networks	17.68%	16.80%	23.28%	21.36%	17.81%	65.33%	4.02%
34	Services	16.77%	13.08%	22.33%	3.21%	18.45%	3.21%	13.99%
35	Infrastructure platform	1.64%	0.88%	24.23%	4.82%	11.26%	10.15%	10.15%
36	Management information system and data processing	10.82%	4.49%	4.49%	12.93%	4.49%	1.58%	12.93%
37	Agent based applications	5.42%	7.23%	7.23%	26.51%	7.23%	26.51%	36.75%
38	Return on investment	27.27%	20.00%	20.00%	9.09%	0.00%	9.09%	9.09%

39	Enterprise resource planning in terms of databases and software	15.02%	9.62%	8.45%	1.41%	9.62%	15.02%	17.84%
40	Technology knowledge management	24.05%	22.03%	16.96%	6.33%	2.53%	11.39%	11.39%
41	Technology identification and selection	42.47%	5.48%	15.62%	15.07%	26.58%	15.07%	4.11%
42	Cyber security	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	SMEs average difference across readiness elements	18.72%	22.01%	16.36%	12.83%	17.39%	24.25%	16.37%

A graphical illustration of the results can be seen in the figure below, which identifies the average absolute percentage difference vs individual absolute percentage differences provided by the SMEs. Respondents 2 and 6, were identified visually in the previous figure as possible outliers with regards to their weightings in comparison to the average among SMEs weightings. From the calculated average in the table above, respondents 2 and 6 has on average the highest percentage differences with regards to the means across all the readiness elements. It has been explained that possible outlier data will be included, due to that it could provide possible insights into new trends with regards to the topic. The figure below should correspond to the findings with regards to the SMEs possible outlier data. From the data gathered above a weighting index is developed to indicate the separate readiness dimension and element weightings.

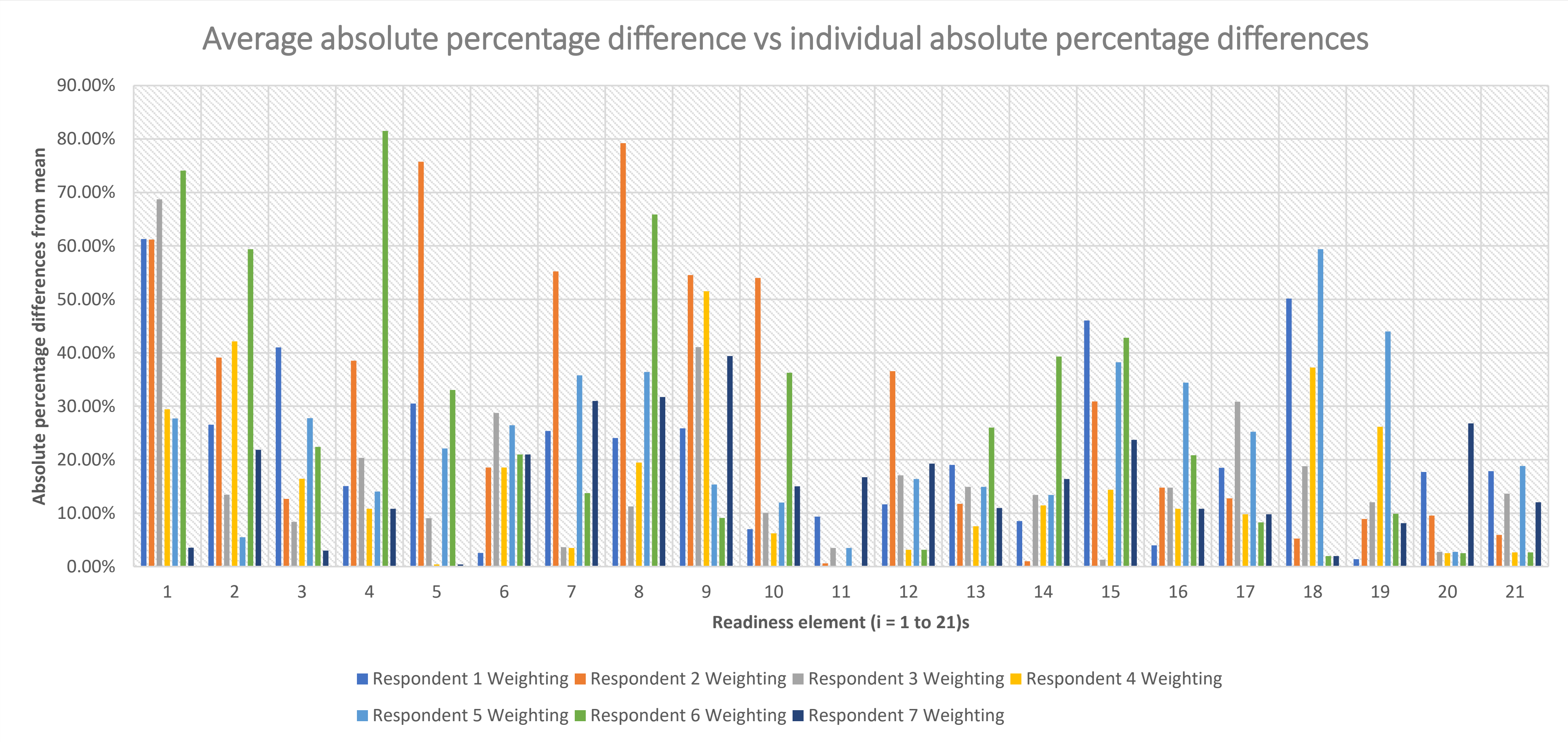

Figure 68. Average absolute percentage difference vs individual absolute percentage differences for readiness elements

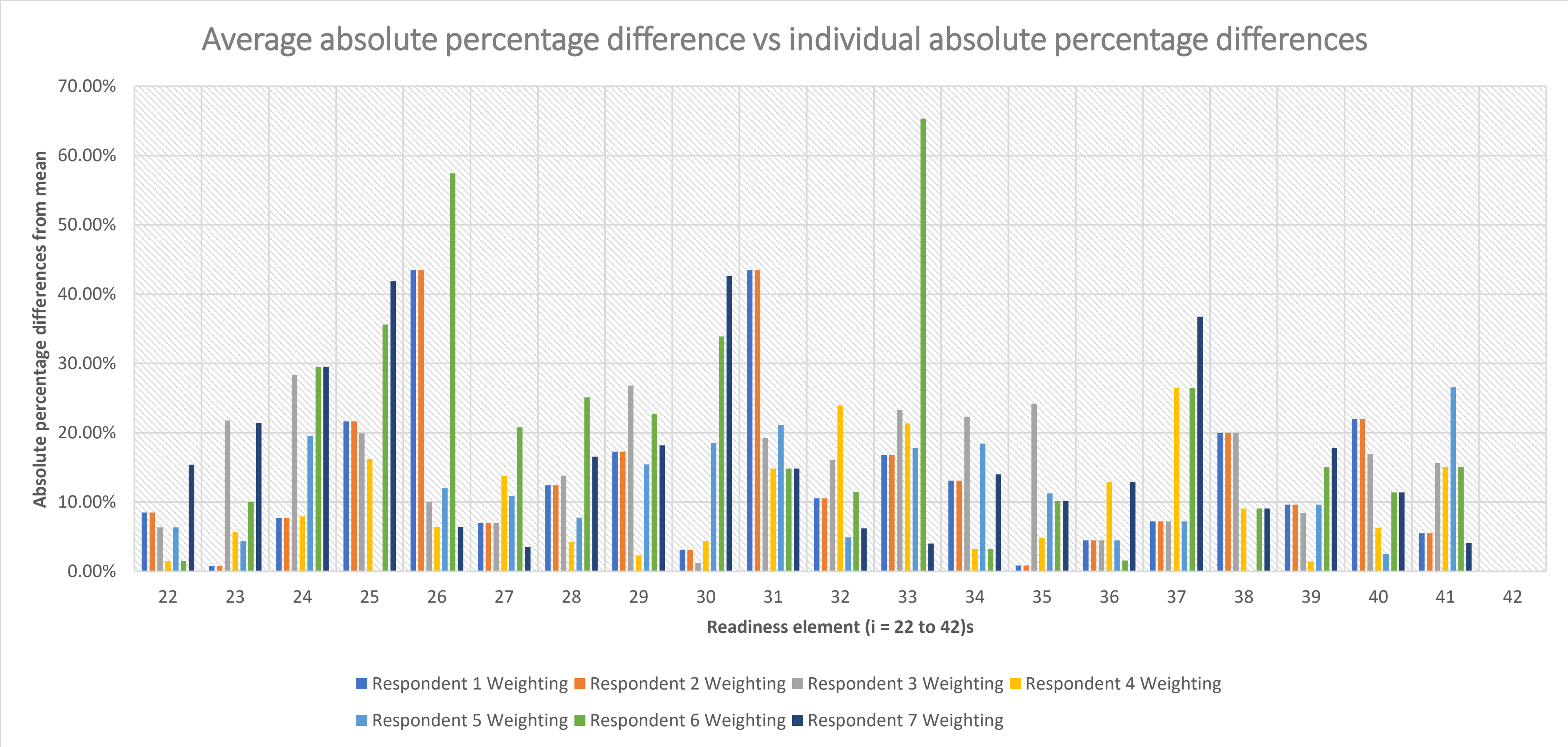

Figure 69. Average absolute percentage difference vs individual absolute percentage differences for readiness elements

Due to the low occurrence, overall importance of multiple readiness variables within each of the readiness elements. The equally weighted average method will be used with regards to these variables, thus assigning equal importance to these variables within each of the readiness elements. From the data gathered above a weighting index is developed to indicate the separate readiness dimensions, element and variable weightings. This weighting index can be seen in the table below.

Table 49. Weightings index for readiness model

d	Wd	Readiness dimension	i	Wd,i	Readiness element	n	Readiness variables	$W_{d,i,n}$
1	0.13492	Employee and Culture	1	0.071537339	Job security	1	Employees' perception on job security with regards to AI	1
			2	0.09119616	Perceived usefulness	2	Employees' perception on the usefulness of AI	1
			3	0.095448613	Perceived ease of use	3	Employees' perception with regards to ease of use of AI	1
			4	0.100272971	Compatibility with existing values and practices	4	Compatibility of AI with business values and practices	1
			5	0.110651481	Benefits	5	Employees' perception on the benefits regarding AI	1
			6	0.093739913	Business Acceptance	6	Perceived business acceptance of AI	1
			7	0.107353375	Skills and expertise	7	Perceived current skills and expertise capability to implement and manage AI	1
			8	0.108493677	Collaboration	8	Willingness of employee collaboration with regards to AI	1
			9	0.061116725	Certainty	9	Willingness of employee collaboration with regards to AI	1
			10	0.081154648	Technological categorization and planning	10	Technological categorization and planning progress for AI	1
			11	0.103537625	Technology requirement handling	11	Identification of technology requirement management structures	1

2	0.14174	Technology Management	12	0.106794588	Technological investment and capital management	12	Allocation of Investment and capital management for AI	1
			13	0.093220681	Cost management	13	Identification of cost management structures for AI	1
			14	0.061877597	Technological competitors' analysis	14	Identification of cost management structures for AI	1
			15	0.090428445	Cloud Resources	15	Identification and selection of cloud computing models, such as infrastructure as a service, Platform as a service or software as a service	0.25
						16	Identification and satisfaction of requirements regarding Cloud computing models	0.25
						17	Identification and selection of cloud computing deployment models, such as cloud, hybrid and on-premises models	0.25
						18	Identification and satisfaction of requirements regarding cloud computing deployment models	0.25
			16	0.108888904	Network Connectivity	19	Identification of required network connectivity within business for AI	1
			17	0.09554736	Technology Risk Management	20	Assign responsibilities and roles for managing risks involving AI	0.2
						21	Prioritisation and identification of information system assets	0.2
						22	Implementation of practices and controls to mitigate risks	0.2

						23	The identification and assessment of the like hood, as well as the impact of current and emerging threats, vulnerabilities and risks	0.2
						24	Implementation of periodic improvement/update and monitoring of risk assessment to include changes in systems, as well as operating/environmental conditions that could affect the risk analysis	0.2
			18	0.08795073	Quality Management	25	Identification and selection of quality management structures for AI	1
			19	0.0956522	Human resource planning	26	Documentation of data regarding the short to long term goals of the AI project	0.5
						27	Effort regarding the identification of the types of resources, people and competencies that will be required	0.5
3	0.14156	Organisational governance and leadership	20	0.220301889	Executive support	28	Executive support regarding AI	1
			21	0.219984076	Budget	29	Allocation of a budget for AI	1
			22	0.190664104	Business opportunity	30	Identification of applicable business opportunities for AI	1
			23	0.205287516	Strategic leadership	31	Identification of strategic leadership, which comply with the activities and characteristics of a strategic leader	1
			24	0.149443784	Business cases	32	Identification of business cases for AI	1

4	0.14541	Strategy	25	0.166473402	Trial-ability	33	Capability to conduct a certain amount of testing (test data)	1
			26	0.151534011	Business clarity	34	Perceived business clarity with regards to AI	1
			27	0.186960696	Observable results	35	Identification of methods and criteria involved with generating observable results during testing/implementation of AI	1
			28	0.15468343	Technology roadmaps and scenarios	36	Identification of technology roadmaps and scenarios regarding AI	1
			29	0.157698441	Technology prospect/forecasting	37	Identification of technology forecasting methods for AI	1
			30	0.168671525	Agile delivery	38	Development of the agile strategy with regards to AI	1
5	0.13334	Infrastructure	31	0.18344235	Technologic sustainability and position map	39	Development of the technology sustainability and position map for AI	1
			32	0.176506607	Communication networks	40	Identification of communication networks involved with operation of AI	1
			33	0.180252557	Information networks	41	Identification of information networks involved with implementation, operation and management of AI	1
			34	0.181662331	Services	42	Identification and mapping of services that will incorporate AI	1
			35	0.20869171	Infrastructure platform	43	Identification of required infrastructure in terms of cloud resources, as well required additional infrastructure sections	1

6	0.13972	Knowledge and information management	36	0.191414141	Management information system and data processing	44	Initiation of the development of management structures for information systems and data processing	1
			37	0.143722944	Agent based applications	45	Conducting agent-based simulations or modelling to indicate possible impacts of AI on business processes	1
			38	0.166666667	Return on investment	46	Calculations of the return on investment for AI	1
			39	0.184415584	Enterprise resource planning in terms of databases and software	47	Identification of enterprise resource planning (databases and software) for AI	1
			40	0.170995671	Technology knowledge management	48	Initiation of technology knowledge management strategies for AI	1
			41	0.158008658	Technology identification and selection	49	Analysis of technology compatibility, system impact of AI and the maturity of the AI	1
7	0.1418	Security	42	1	Cyber Security	50	Identification and development of management of cyber security with regards to Artificial intelligence	1

6.2.4 Weighting Conclusion

The conclusion of the weighting factors focuses on discussing the insights that have been gained in completion of this section. The focus of the development of weighting factors was to determine the readiness dimension and elements weightings through the administration of surveys to SMEs. The initial weightings methods discussed was the Likert scale and the AHP method. The Likert scale would be used to determine the readiness dimensions and the readiness element weightings would be determined by using the AHP weighting method. Two SMEs were approached and they completed the administered weighting surveys. The Likert scale weightings for the readiness dimensions were developed, the focus then shifted towards the evaluations of the completed pair-wise comparison matrices, towards the development of the readiness element weightings using the AHP method. During the consistency tests, which determines the usability of the weightings in the study, it was found that the experts had inconsistent evaluations across the pair-wise matrices. A disadvantage with regards to this method was identified in section 6.2.1 with regards to inconsistencies, which was reflected in the study. Due to time and SME cooperation limitations, it was decided to incorporate the Likert scale method to determine the readiness element weightings. As the SME focus with regards to these readiness elements could still incorporate a comparative basis, the decision was made to weight each readiness element within their perspective dimensions (similar to the AHP method), rather than the total list of readiness elements. There were some interesting findings with regards to the weightings developed from the SMEs insights. The three highest weighted readiness dimensions are strategy, technology management and security. It was interesting to find that none of the readiness dimensions were excessively more or less important to the others. The readiness dimensions were very closely weighted in importance. This suggest that all the readiness dimensions proposed can be considered important when looking at it comparatively. There were no apparent outliers with regards to the readiness elements.

6.3 Development of the importance-performance analysis

The IPA has been used in tourism research for many years since the work of Martilla and James (Martilla and James, 1977). Factors that contribute to the wide acceptance of this model are: ease of application and the presentation of both data and strategic suggestions (Oh, 2001). The IPA is a combination of measures between two attributes namely importance and performance on a two-dimensional grid (Oh, 2001). This provides ease of data interpretation, as well as the derivation of practical suggestions (Oh, 2001). The IPA generates four different suggestions based on the importance-performance measures (Oh, 2001). The suggestions form quadrants which can be seen in the figure below.

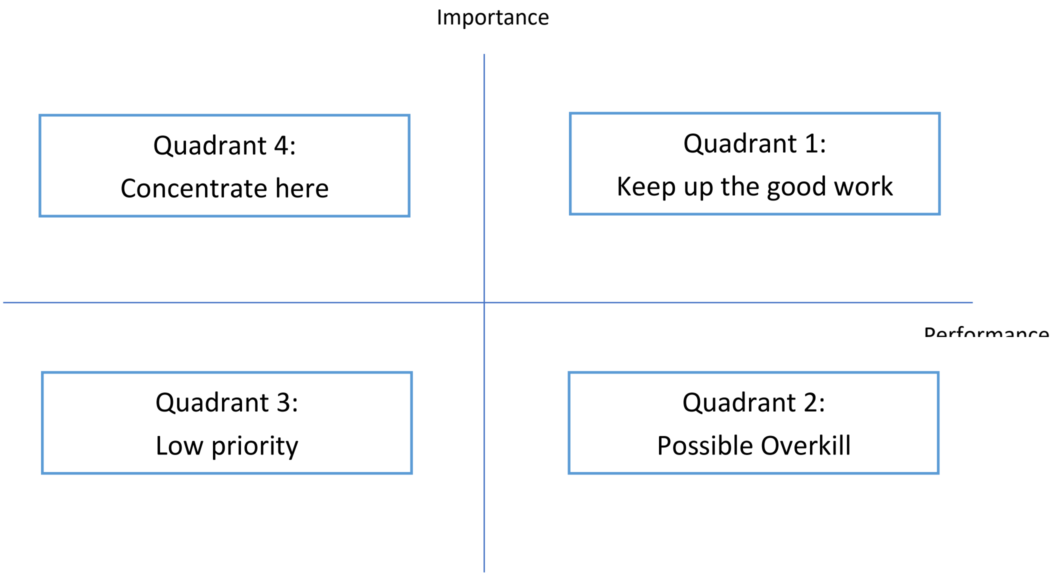

Figure 70. importance-performance analysis original axis

In terms of the readiness model the quadrants will be described as followed. The first quadrant indicates attributes that are deemed important and the company/business/case study experts perceive it as performing well. The second quadrant indicates attributes that are relatively less important, but the company performs well in these areas. The third quadrant indicates attributes that are low on importance and perceived performance. These attributes likely receive low priority in terms of resource allocation (Oh, 2001). The fourth quadrant indicates attributes that the SMEs perceive as a high priority, but the business' perceived performance is not sufficient. The IPA provides a combined view to easily show how well the business is performing with regards to important attributes, as well as indicating where future resource allocation to improve the business (Oh, 2001).

The IPA has been subjected to some controversy since its beginning. These are due to the position of the axis, which determines quadrants and interpretations, as well as the measurement of importance and performance of elements, which indicate the service being assessed (Rial *et al.*, 2008). The IPA graph suffered from low discriminative power and low utility with regards to management (Rial *et al.*, 2008). The revised approach for this method is the combination of crossing the axis at the empirical mean, as well as the incorporation of the concept of discrepancies. The empirical means method will be used to categorize the case study business' readiness elements and dimension in terms of short-term strategy, due to the origin shift of from the empirical means incorporations. The incorporations of discrepancies are done by computing the difference between performance and importance, through the incorporation of a diagonal line on the graph and distance of each point from the line is considered (discrepancies) (Rial *et al.*, 2008). The line connects all points where there are no discrepancies (importance matches performance), this thus forms a 45-degree line when both axes of the graph are identical in terms of increments. The points above the diagonal line indicate negative discrepancies (importance>performance), whereas points below the diagonal line indicates a positive discrepancy (importance<performance) (Rial *et al.*, 2008). The diagonal line method will be used for long term strategy in terms of readiness element categorization. This is due to the diagonal line that is set in terms of the importance and performance irrelevant of the average of the performance or performance of the readiness elements. The approach is further improved by the re-interpretation of the graph as seen in the figure below (Abalo, Varela and Rial, 2006).

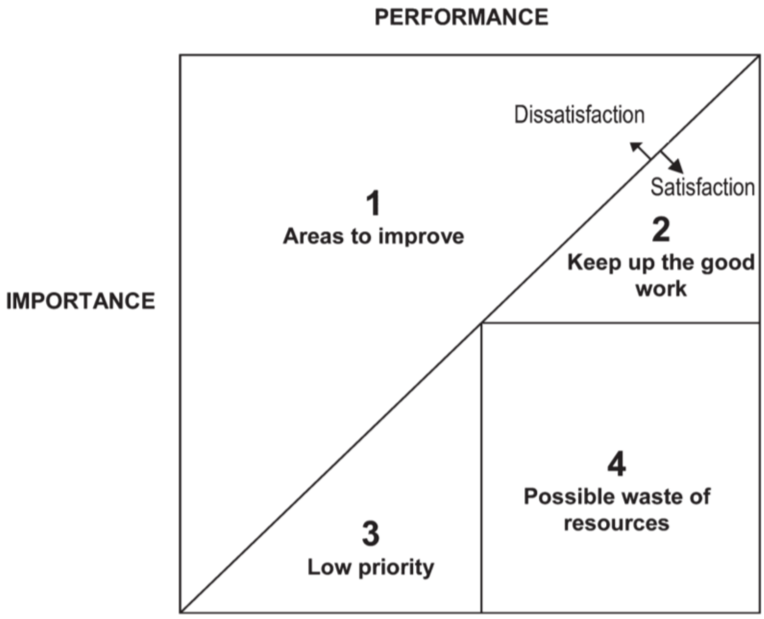

Figure 71. Re-illustration of the IPA graph (Abalo, Varela and Rial, 2006)

The focus for this study would be determine the importance/weighting of each readiness element through the use of weighting methods, such as the Likert scale and AHP method and surveys. The performance will be measured by surveys conducted with case study subject matter experts; this thus indicates that the performance evaluation is qualitative in nature due to it being opinion based. In terms of graphical representation of the importance performance analysis, this study will combine the use of the diagonal line method (45-degree angle), with identical axis increments and an original axis, which crosses at the empirical means of the data. There will be combined and separate views regarding the re-illustrated diagonal line interpretation and the original IPA axis interpretation.

The original axis' origin is determined by calculating the empirical means of the data regarding importance/weightings and performance/satisfaction. The $\boldsymbol{W_i}$ seen below is determined through the multiplication of two weightings that were determined ($\boldsymbol{W_i = W_d . W_d, i}$). These being the weighting of the readiness dimension ($\boldsymbol{W_d}$) determined through the Likert scale and the readiness element weightings ($\boldsymbol{W_d, i}$) determined through the use of the AHP method or Likert scale. This can be seen in the formula below.

$$\text{Origin Coordinates} = (\text{Mean } (\boldsymbol{W_i}); \text{Mean } (\boldsymbol{P_i}))$$

6.4 Development of the readiness evaluation

For this section the framework used for developing the maturity model developed by Schumacher, Erol and Sihn (Schumacher, Erol and Sihn, 2016), will be adjusted using the AI readiness dimensions identified in the previous sections. The model is comprised of defining overall readiness dimensions, and elements within each of the dimensions. These can be seen in Table 28. The surveys in the model are used to determine the weightings and maturity of an item.

The readiness level of each dimension ($\boldsymbol{R_d}$) is determined by calculating the weighted average of all readiness elements' performance ($\boldsymbol{P_{d,i,n}}$) within its dimension. This is done by using the calculations as seen below.

$$R_d = \sum_{l=1}^{i} R_{d,l} \cdot w_{d,l}$$

Where $R_{d,i}$: performance of Readiness element

and $w_{d,i}$: Weighting of readiness element

$$R_{d,i} = \sum_{l=1}^{n} P_{d,i,n} \cdot w_{d,i,n}$$

Where $P_{d,i,n}$: Average of performance/satisfaction rating of readiness variable across all respondents

and $w_{d,i,n}$: Readiness variable weight

$$P_{d,i,n} = (\sum_{l=1}^{S} P_{l,d,i,n})/\mathrm{S}$$

Where $P_{d,i,l}$: Performance/satisfaction rating of readiness variable

and S : Number of respondents

These results of these calculations will be graphically displayed to provide the user with a simpler view of the findings and indicate which dimensions, elements and variables are mature and those that require more attention in the future to further develop their readiness. Graphical illustration will indicate the business' readiness through a comparative lens, in terms of Business dimension readiness and between readiness element within each of these dimensions. Examples can be seen in the figures below.

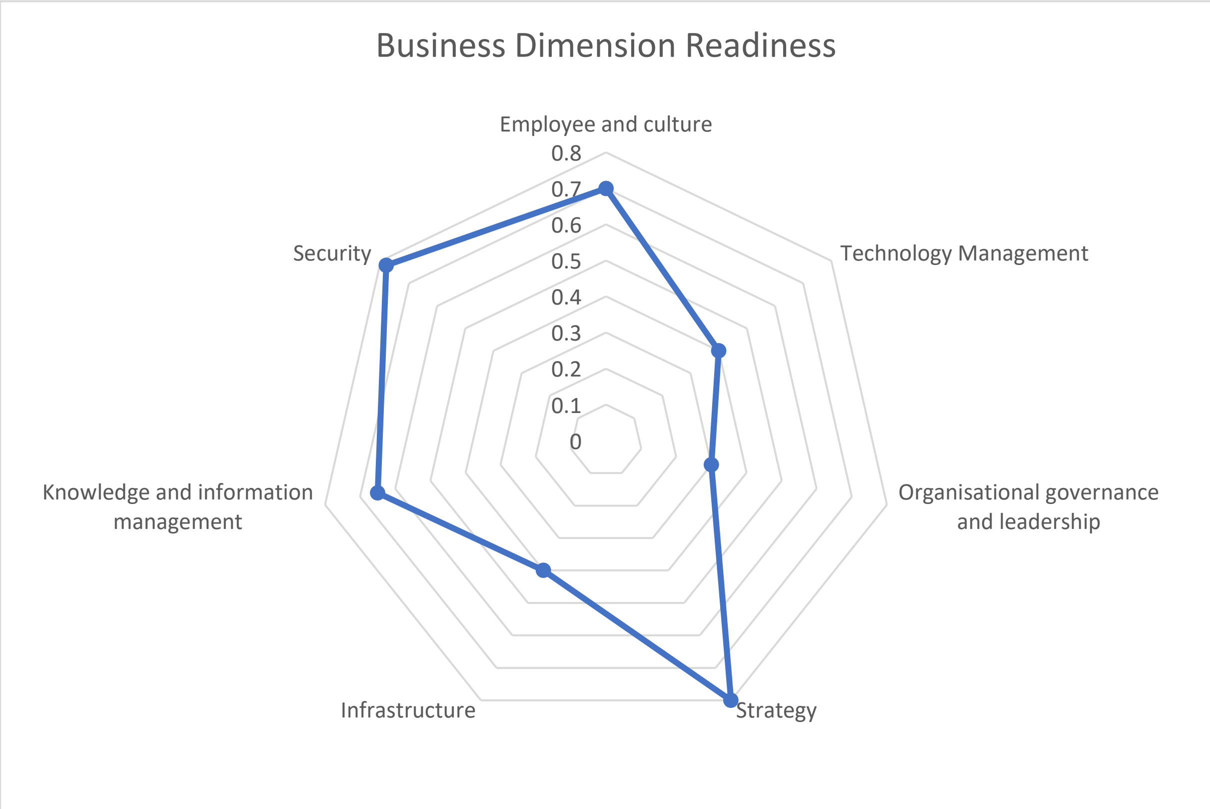

Figure 72. Business dimensions readiness example

Figure 73. Example of employee and culture readiness

These are examples of the type of graphs that will be generated, to provide insights into the business' readiness through the comparative lens between dimensions and readiness elements within each of these dimensions. This provides the business with a numerical evaluation of its readiness with regards to artificial intelligence implementation. This can be used in collaboration with the IPA to generate a way for the business to evaluate, categorize and prioritize readiness dimensions and elements.

6.5 Construction of readiness model conclusion

In conclusion, this chapter has completed all the pre-requisites for the developed readiness model to be applied to a case study. This was initiated by the development and application of the validation process with regards to this study. This followed be the development of the methods used to determine/calculate the weightings of the readiness model, as well as calculation of the readiness model calculations. The calculations of the weightings made use of the Likert scale for both the dimensions and elements, due to that the AHP method results were too inconsistent to be used, as well as the time and cooperation limitations within the timeframe of this project. The surveys that were administered not only focused on determining weightings, but also to further validate the developed model in terms of identifying if the readiness dimensions and elements that were developed were applicable to this study and the aimed outcome. The development of the readiness model weightings is completed and some insights are discussed around it, such as the absolute distance from mean. This resulted in the final development of the weighting index, which is used to conduct the case study in the following section. An interesting finding with regards to the readiness dimensions weightings, is the fact that the weightings have no large outliers, thus showing the readiness dimensions to be quite balanced. As all the preparations are completed, the readiness model will be applied to a case study in the following chapter.

Chapter 7: Case study

In previous chapters, the readiness model has been developed and the readiness dimension and elements re-synthesized through interviews and surveys conducted with SMEs. The focus of this section is to apply the developed model to an applicable case study. The application of this model could determine strengths, weaknesses, possible improvements and future possibilities for the developed readiness model.

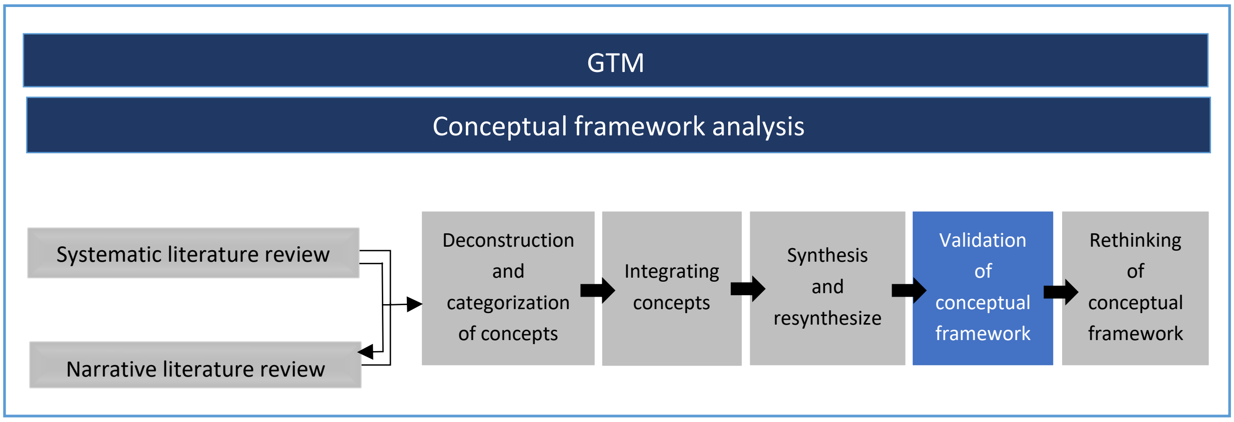

Figure 74. Study methodology steps

Chapter 7 Objectives	Develop requirements regarding case study
	Identification of viable case study
	Provide background information on case study
	Conduct case study
	Analyse the results

The main process illustration of the study can be seen in the figure below. The development of the readiness model dimensions, and elements have been completed and can be seen as the top layer. The next layer is the development of the readiness model weightings through SME inputs. The current chapter focuses on obtaining case study evaluations from employees and developing the IPA and evaluating the business' readiness for artificial intelligence.

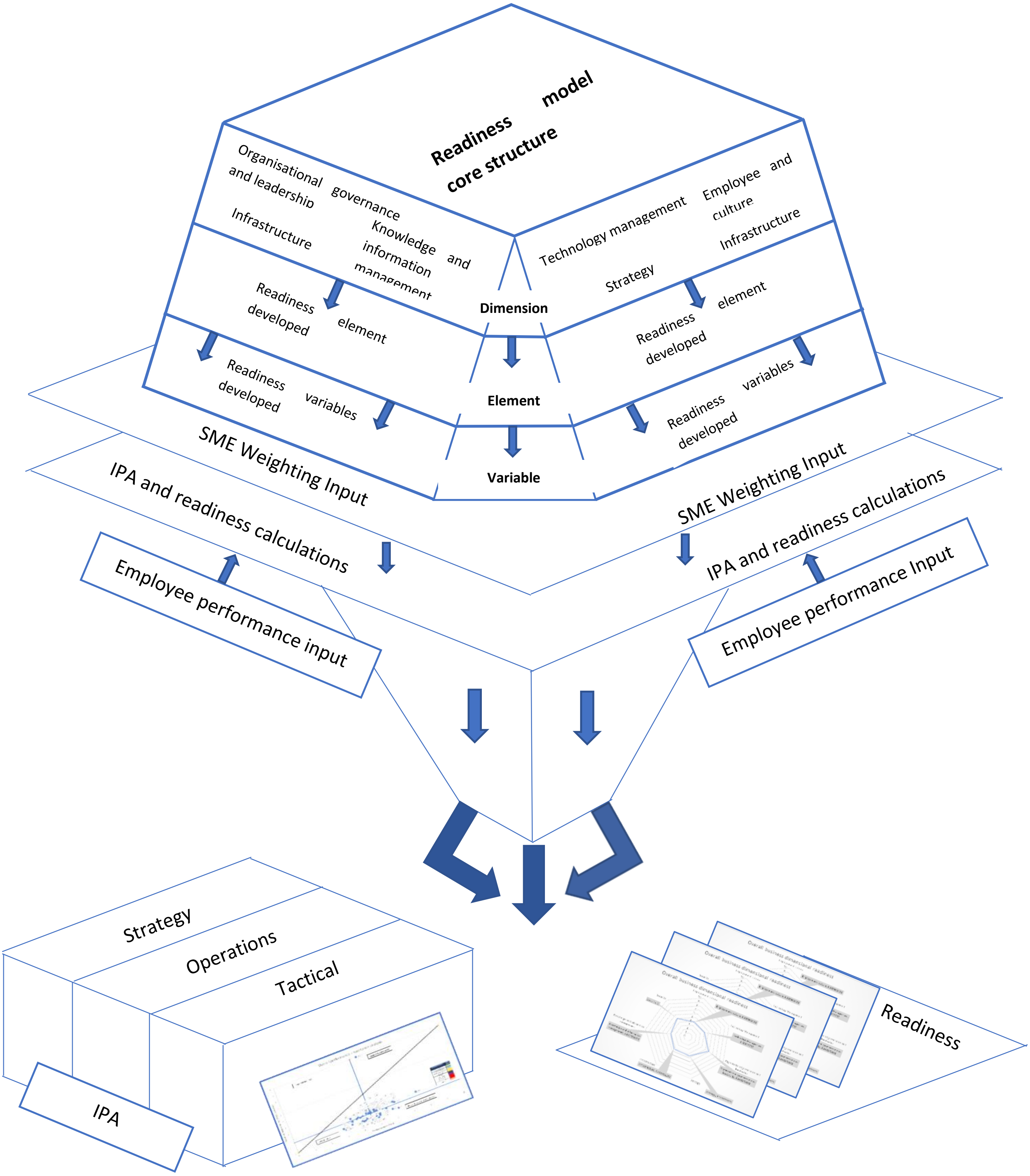

Figure 75. Readiness model illustration of case study inclusion and output

There are two main outputs with regards to this chapter. These two outputs are the graphical results provided by the importance-performance analysis and the business readiness calculation results. The importance-performance analysis outputs are summarized as:

- ***Overall*** (combination of strategy, operations and tactics) importance-performance analysis results including three weightings factors (readiness dimension, element and variable weightings)
- Importance-performance analysis of ***strategy*** including three weightings factors (readiness dimension, element and variable weightings)
- Importance-performance analysis of ***operations*** including three weightings factors (readiness dimension, element and variable weightings)
- Importance-performance analysis of ***tactics*** including three weightings factors (readiness dimension, element and variable weightings)

These analyses provide the reader with different perspectives on importance and performance with regards to this study. The Basic, two weighted IPA, provides a simple and quick analysis of the data. The other types of IPA's incorporate three weighting factors and provide results focused specifically on strategy, operations and tactics, as well as overall IPA, which includes the combined weightings of the strategy, operations and tactics sections. It is important to note that the 3 weighted IPA's are illustrated as relative importance vs performance, due to the method that was used to determine the weightings does not allow for it to be directly scaled for use in the IPA. The IPA sections can be seen in the Figure 76.

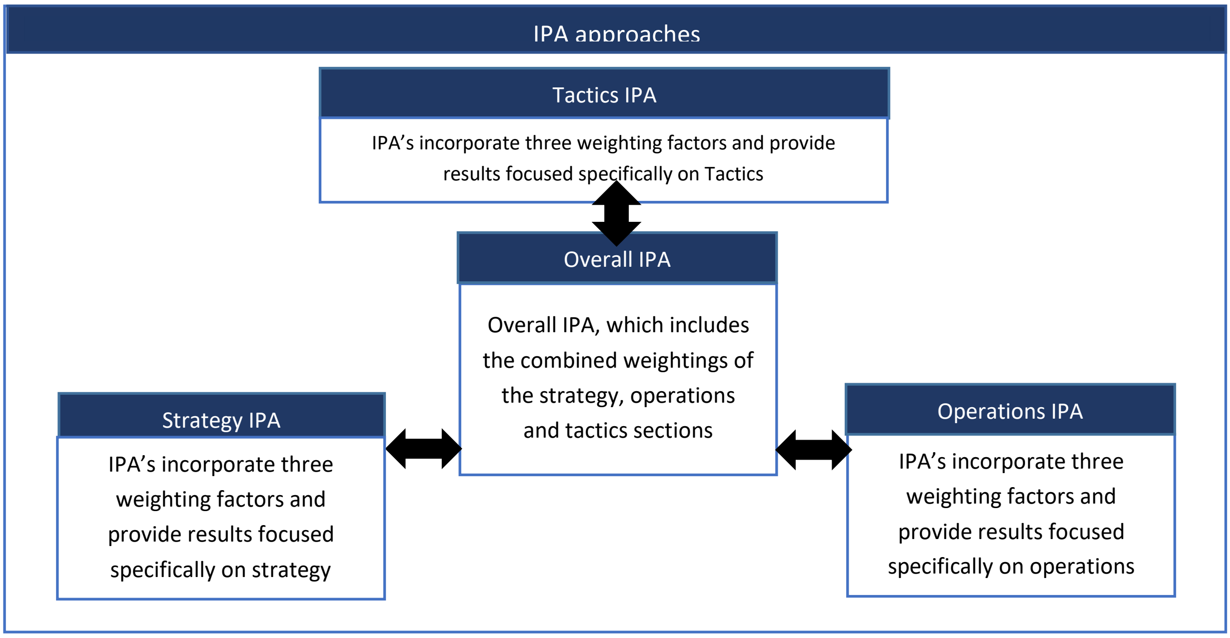

Figure 76. IPA Approaches

The business' readiness is determined through weighted average calculations. This section is divided into two main parts. The first phase is identifying the business' overall readiness for artificial intelligence through the presentation of the business' dimensional readiness. The second phase indicates the business' dimensional readiness through the presentation of the various readiness elements performance within that specific dimension. The following sections provide a description of the case study background, as well as the proceedings and results of the case study with regards to the model developed.

7.1 Case study requirements, selection and background

When revisiting the problem statements and project objectives. The main focus of this study is the development of a technology readiness model aimed towards assessing artificial intelligence readiness of a business, as well as testing its applicability on a case study. With regards to selecting the applicable case study, some requirements are set in place to identify a viable and valuable case study with regards to this study.

The first requirement that was identified with regards to the study is that the business/enterprise has to be at the initial phase of AI implementation, thus some level of executive support is given towards possible AI research and design. This requirement potentially indicates that the company has to a certain degree some digital/cognitive knowledge, experience and foundations, as well as a digitized culture. This is seen as a positive input into the case study in terms of evaluation accuracy and productivity.

A second requirement involves individuals who will partake in the evaluation study. These respondents are required to be aware of and need some knowledge or experience with regards to cognitive projects, such as digitalization, robotic process automation and artificial intelligence. To produce a more balanced result from the evaluations, the respondents partaking in the evaluation surveys also need to originate from different divisions and at different levels of management within the business.

Through interviews and research, a large insurance company (from now on referred to as Company X) has been identified, which pass the following requirements:

- The business is in the starting phases of AI implementation/research/design for the business.
- Individuals in the business have basic, as well as more experienced knowledge with regards to AI from a technical, business and management perspective.
- Individuals with the required knowledge are present in different levels and divisions within the business.
- The organization and individuals have agreed to partake in the study and the required documentation has been completed.

Company X, which forms part of the case study provides financial solutions to a variety of client types such as individuals, small-medium sized businesses and large corporations across Africa and Asia. The main business offerings can be seen in Figure 77 .The company employs roughly around 30 000 people and is involved in markets, such as insurance, investments, lending and banking. In terms of insurance the business provides life assurance-based products and short-term insurance solutions. The investment sections encompass direct asset management or services such as the use of multi-mangers to invest in a selection of funds. The company provides personal and debt consolidation loans. The business provides a range of innovative banking services and products. Long term goals of the business with relevance to the study topic, is the aim of becoming a digital platform business, this encompasses the simplification and digitization of journeys for employees, intermediaries and customers. In terms of the business, the focus of digitalization is to develop deeper insights into specific customer needs through accelerated use of analytics and real-time data. The business has successfully launched and integrated robotic process automation into its business structures and is exploring possible avenues to leverage artificial intelligence to generate value for the business.

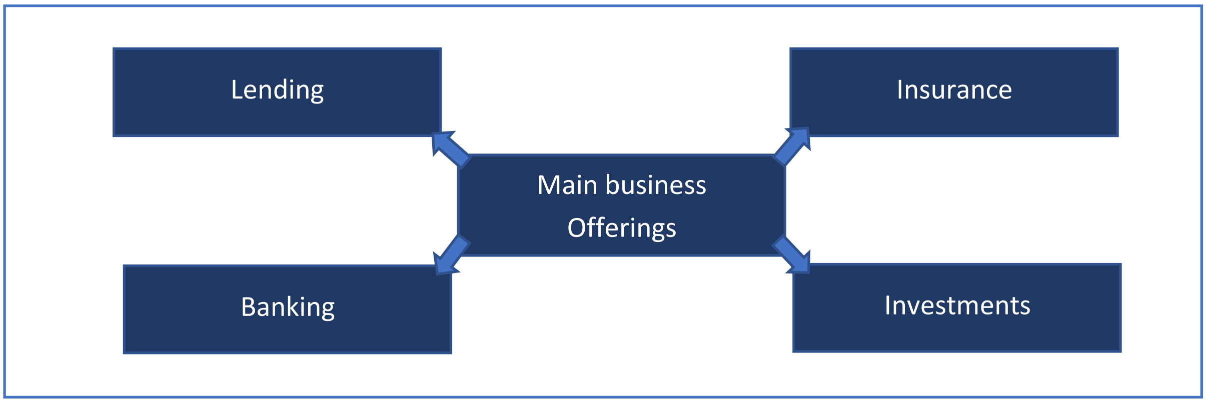

Figure 77. Main business offerings

7.2 Conducting the case study

The study was initialized through scheduled meetings, interviews and finally the administration of surveys. The data collection towards the completion of the case study is divided into three phases namely, interview objectives, survey administration objectives and post survey interview objectives. The interview objectives are conducting a presentation on the develop readiness model, gather information on individuals that fulfil requirements and provide information and assistance to interviewees with regards to the model, assist in the accuracy of evaluations. The survey administration objectives are administering the surveys and providing continuous assistance, by answering any questions involved in this study. The post survey and interview objectives are to gather information of interviewees with regards to the perceived usefulness of the developed model and identify more possible needs from the model. The process followed for collection of data from the SMEs within the business can be seen in the figure below.

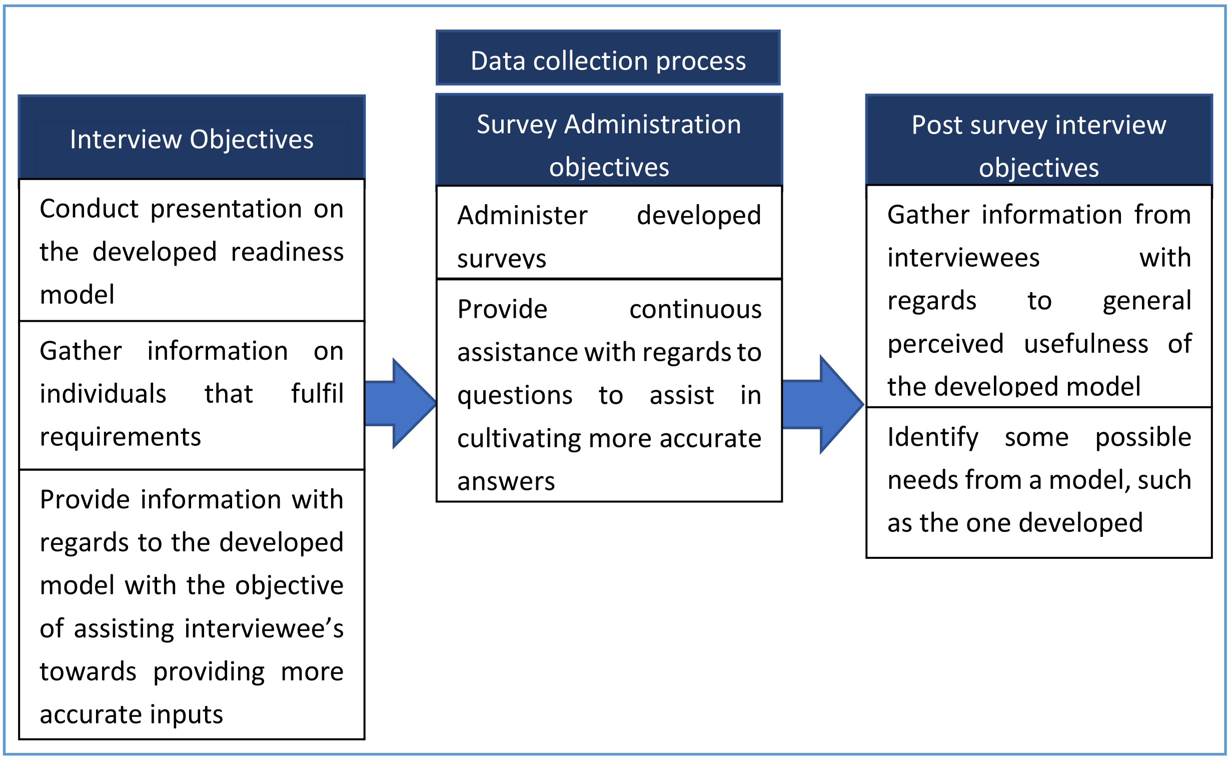

Figure 78. Case study data collection

The data collection with regards to case study follows the process steps in the figure above. The initial semi-structured interviews were conducted with certain identified individuals, which have satisfied the requirements previously stated and have agreed to partake in the study. An example of this survey can be seen in Appendix I. It is important to note that the interviews and administration of the surveys were conducted in person to best try avoid any misunderstandings and to easily answer any questions with regards to the study, as well as the data provided by the employees are completely anonymous so as to potentially improve data accuracy. Presentations were given to these individuals to explain the core parts of the framework, as well as their roles with regards to the study. The surveys were administered and explained in detail, as well as with the objective to improve efficiency with regards to the reduction of misunderstandings and duration until feedback. After the surveys have been completed, another short interview was conducted with these individuals regarding their perceived usefulness and applicability of the model with regards to their business and AI implementation. The overall consensus from all the individuals that participated in the study, was that the developed model, together with its elements are definitely useful and applicable towards the business and possible future challenges. This served as a further validation that the model developed, could mainly serve its proposed purpose and be useful in the realm of technological readiness of businesses wishing to implement and leverage AI in their business.

The participant was required to complete a Likert scale method evaluation survey, whereby they rate the current perceived performance of the business and employees with respect to the developed readiness element and variables. The individual inputs are identified as performance, but should be noted that the individuals are providing their personal ratings/insights with regards to these various components of the business, thus the performance mentioned more closely resembles satisfaction of the individuals as the data acquired by these individuals are qualitative in nature. The transformation towards the incorporation of performance and quantitative data, is further discussed in the following chapter. As stated, before the exact titles and professions of the individuals that participated are withheld to ensure anonymity internally and externally across the business. It is important to note that the individuals all pass the requirements set out and range from the management of cognitive projects, research and design to Management of business with connection to artificial intelligence.

The performance/satisfaction ratings are enumerated between 1 being the lowest possible performance/non-existent and 10 as the highest possible performance/ready for AI. The reason for choosing a 10-point Likert scale, is due to the fact that the importance-performance analysis' graphical outputs' axis ranges from 1 to 10. This range thus provides more options for the individuals to provide their insights, as well as removes the necessity to scale up the retrieved data for the importance-performance analysis. The results pertaining the performance/satisfaction ratings can be seen in the Table 50. The data that will be used in the performance-satisfaction analysis and the overall readiness evaluation is the average rating for every element across all respondents.

Table 50. Business performance evaluation results

i	Readiness elements (i)	n	Variable description	Respondent Performance 1	Respondent Performance 2	Respondent Performance 3	Respondent Performance 4	Respondent Performance 5	Respondent Performance 6	Respondent Performance 7	Respondent Performance 8	Respondent Performance 9	Average Pi	Standard deviation
1	Job Security	**1**	Employees' perception on job security with regards to AI	7	1	6	2	2	2	2	3	2	3.000	1.944
2	Perceived usefulness	**2**	Employees' perception on the usefulness of AI	8	5	6	5	5	4	3	6	4	5.111	1.370
3	Perceived ease of use	**3**	Employees' perception with regards to ease of use of AI	2	5	8	8	4	4	2	2	7	4.667	2.357
4	Compatibility with existing values and practices	**4**	Compatibility of AI with business values and practices	8	2	5	5	3	5	1	4	7	4.444	2.114
5	Benefits	**5**	Employees' perception on the benefits regarding AI	5	1	8	6	7	5	6	6	9	5.889	2.131
6	Business Acceptance	**6**	Perceived business acceptance of AI	5	6	7	8	7	4	3	6	10	6.222	1.988
7	Skills and expertise	**7**	Perceived current skills and expertise capability to implement and manage AI	1	1	4	3	3	5	4	5	5	3.444	1.499
8	Collaboration	**8**	Willingness of employee collaboration with regards to AI	4	3	7	5	2	4	3	6	7	4.556	1.707
9	Certainty	**9**	Employees' perceived trust/certainty in AI	4	1	5	4	4	3	1	5	2	3.222	1.474
10	Technological categorization and planning	**10**	Technological categorization and planning progress for AI			7	3	2	4	3	4	6	4.143	1.641
11	Technology requirement handling	**11**	Identification of technology requirement management structures		7	5	2	2	5	4	4	7	4.500	1.803

12	Technological investment and capital management	**12**	Allocation of Investment and capital management for AI	3	7	4	4	1	6	2	3	9	4.333	2.404
13	Cost management	**13**	Identification of cost management structures for AI	1	8	6	7	2	6	3	2	9	4.889	2.767
14	Technological competitors' analysis	**14**	Technological competitors' analysis for AI			6	3	3	7	5	2	9	5.000	2.330
15	Cloud resources	**15**	Identification and selection of cloud computing models, such as infrastructure as a service, Platform as a service or software as a service		5	7	4	1	6	6	5	6	5.000	1.732
		16	Identification and satisfaction of requirements regarding Cloud computing models		2	7	1	1	6	5	5	5	4.000	2.179
		17	Identification and selection of cloud computing deployment models, such as cloud, hybrid and on-premises models		2	7	3	1	7	7	4	5	4.500	2.236
		18	Identification and satisfaction of requirements regarding cloud computing deployment models		2	5	1	1	7	3	4	5	3.500	2.000
16	Network Connectivity	**19**	Identification of required network connectivity within business for AI		6	7	3	3	5	4	6	7	5.125	1.536

17	Technology Risk Management	**20**	Assign responsibilities and roles for managing risks involving AI	1	5	6	4	1	3	2	3	4	3.222	1.618
		21	Prioritization and identification of information system assets	3	2	8	0	2	5	4	4	6	3.778	2.250
		22	Implementation of practices and controls to mitigate risks	1	4	8	6	5	6	6	4	4	4.889	1.853
		23	The identification and assessment of the like hood, as well as the impact of current and emerging threats, vulnerabilities and risks	1	4	5	3	3	7	5	3	4	3.889	1.595
		24	Implementation of periodic improvement/update and monitoring of risk assessment to include changes in systems, as well as operating/environmental conditions that could affect the risk analysis	1	6	5	6	6	7	5	5	4	5.000	1.633
18	Quality Management	**25**	Identification and selection of quality management structures for AI	2	1	7	3	2	5	2	2	2	2.889	1.792
19	Human resource planning	**26**	Documentation of data regarding the short to long term goals of the AI project	1	2	7	6	1	4	4	5	2	3.556	2.061

		27	Effort regarding the identification of the types of resources, people and competencies that will be required	3	7	7	7	2	6	3	4	2	4.556	2.061
20	Executive support	**28**	Executive support regarding AI	9	10	7	8	4	6	6	7	10	7.444	1.892
21	Budget	**29**	Allocation of a budget for AI	3	5	5	4	1	7	1	4	10	4.444	2.671
22	Business opportunity	**30**	Identification of applicable business opportunities for AI	4	8	6	6	5	7	5	4	10	6.111	1.853
23	Strategic leadership	**31**	Identification of strategic leadership, which comply with the activities and characteristics of a strategic leader	10	4	7	4	2	8	4	5	10	6.000	2.708
24	Business cases	**32**	Identification of business cases for AI	3	5	8	5	5	6	4	4	10	5.556	2.061
25	Trial-ability	**33**	Capability to conduct a certain amount of testing (test data)	7	6	9	1	1	5	3	3	10	5.000	3.091
26	Business clarity	**34**	Perceived business clarity with regards to AI	3	2	6	2	2	6	3	4	6	3.778	1.685
27	Observable results	**35**	Identification of methods and criteria involved with generating observable results during testing/implementation of AI		1	7	6	2	6	3	3	9	4.625	2.595

28	Technology roadmaps and scenarios	36	Identification of technology roadmaps and scenarios regarding AI			6	6	3	7	3	5	7	5.286	1.578
29	Technology prospect/forecasting	37	Identification of technology forecasting methods for AI			6	2	2	6	4	3	6	4.143	1.726
30	Agile delivery	38	Development of the agile strategy with regards to AI	6	3	5	5	2	6	4	3	10	4.889	2.233
31	Technologic sustainability and position map	39	Development of the technology sustainability and position map for AI			7	1	2	7	3	4	10	4.857	2.997
32	Communication networks	40	Identification of communication networks involved with operation of AI			7	2	1	5	4	5	10	4.857	2.799
33	Information networks	41	Identification of information networks involved with implementation, operation and management of AI			7	1	1	5	4	4	10	4.571	2.969
34	Services	42	Identification and mapping of services that will incorporate AI		3	6	3	1	5	4	4	10	4.500	2.500
35	Infrastructure platform	43	Identification of required infrastructure in terms of cloud resources, as well required additional infrastructure sections			6	1	2	7	4	4	10	4.857	2.850
36	Management information system and data processing	44	Initiation of the development of management structures for information systems and data processing	2	1	6	1	2	6	3	3	7	3.444	2.166

37	Agent based applications	**45**	Conducting agent-based simulations or modelling to indicate possible impacts of AI on business processes		1	7	1	2	6	2	2	7	3.500	2.500
38	Return on investment	**46**	Calculations of the return on investment for AI	5	1	6	5	4	7	2	2	10	4.667	2.667
39	Enterprise resource planning in terms of databases and software	**47**	Initiation of enterprise resource planning (databases and software) for AI	2		7	3	2	8	3	4	6	4.375	2.176
40	Technology knowledge management	**48**	Initiation of technology knowledge management strategies for AI	1		5	1	2	8	4	4	6	3.875	2.315
41	Technology identification and selection	**49**	Analysis of technology compatibility, system impact of AI and the maturity of the AI	1	6	6	1	2	7	3	4	6	4.000	2.211
42	Cyber security	**50**	Identification and development of management of cyber security with regards to Artificial intelligence			4	1	4	8	7	7	4	5.000	2.268

The calculation of each individuals' average percentage difference from the mean across all elements should provide more insight into the correlation of the mean of performance and individual's inputs. With regards to possible outliers in the data, occurrence of outliers is included in the study so as to include possible new and different views on the company's performance. Seeing as the evaluations range from values 1-10 (n=10), each increment is seen as 10%, thus the percentage difference is calculated as:

$$\text{Percentage difference from mean} = \left(\left| P_{d,i,average} - P_{d,i} \right| / n \right) \times 100\%$$

The results of the average difference from the mean can be seen in the two tables below. This provides some insights with regards to potential outliers and possible groupings of the respondents. The table with detailed results can be seen in Appendix D.

Table 51. Percentage absolute difference from the mean for respondents 1 to 5

Respondent number	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5
Average % difference of evaluations across all variables	21.43%	18.94%	18.53%	17.06%	20.93%

Table 52. Percentage absolute difference from the mean for respondents 6 to 9

Respondent number	Respondent 6	Respondent 7	Respondent 8	Respondent 9
Average % difference of evaluations across all variables	15.42%	13.29%	9.54%	27.67%

It is important to note as previously stated that individuals whose data is seen as an outlier, will be incorporated as this could influence the data in a new and important way. The results of the average difference from mean across all elements is graphically illustrated in the figure below.

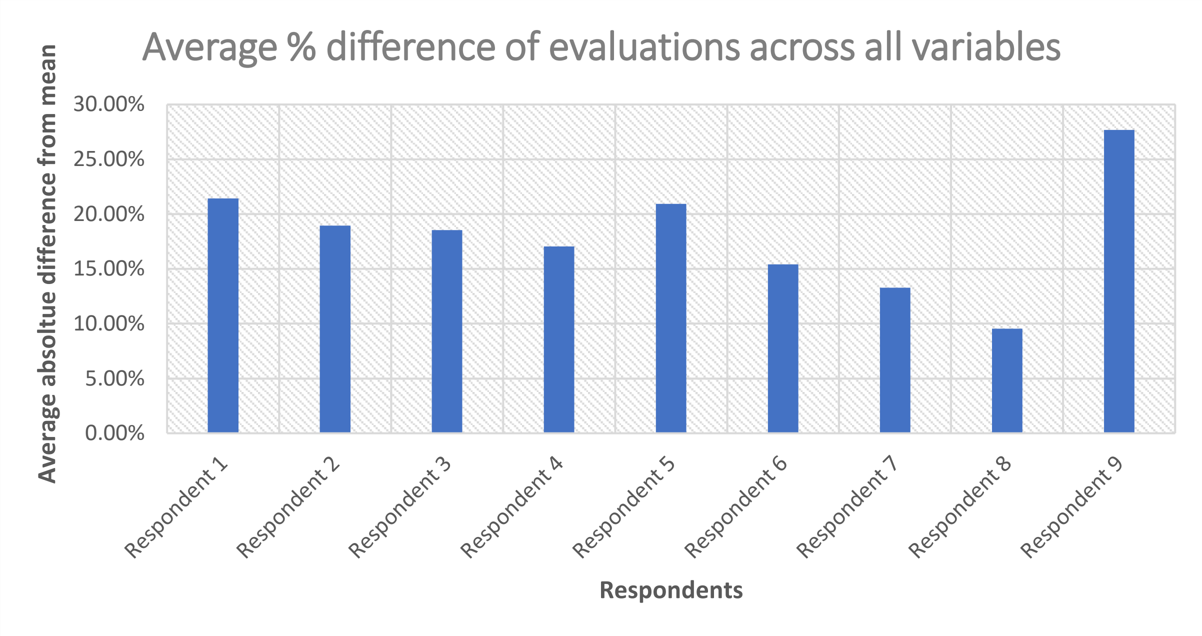

Figure 79. Case study respondents' average absolute difference from mean

7.3 Importance performance analysis (IPA)

The IPA is a combination of measures between two attributes namely importance and performance on a two-dimensional grid (Oh, 2001). This provides ease of data interpretation, as well as the derivation of practical suggestions (Oh, 2001). The following section encompasses the IPA methods developed for this section, as seen in Section 6.3. This section is dived into two major parts. These parts are the basic IPA and the overall, strategic, operation and tactical IPA sections. The basic IPA section focuses on the results from a quick and simple, two weighted IPA. The other section forms the detailed three weighted IPA. The results and interpretations can be seen in the section below. The next part of the importance-performance analysis section focuses on the calculation and illustration of the following parts:

- Overall (combination of strategy, operations and tactics) importance-performance analysis results including three weightings factors (readiness dimension, element and variable weightings)
- Importance-performance analysis of strategy including three weightings factors (readiness dimension, element and variable weightings)
- Importance-performance analysis of operations including three weightings factors (readiness dimension, element and variable weightings)
- Importance-performance analysis of tactics including three weightings factors (readiness dimension, element and variable weightings)

For the calculation and development of this IPA section, the W_i seen below is determined through the multiplication of two weightings that were determined ($W_i = W_a \,. W_a, i$). These being the weighting of the readiness dimension (W_d) determined through the Likert scale and the readiness element weightings (W_d, i) determined using the Likert scale method as well. Seeing as the performance is determined through a scale of 1-10. The overall weighting W_i is determined as stated above, thereafter the weighting is normalized by determining the relative weighting of every element with regards to the highest weighted identified element.

$$W_{i,relative} = \frac{W_i}{W_{i,maximum}}$$

The developed relative weightings are the scaled up according to the IPA axis scale, which is shown the formula below.

$$W_{i,relative} = W_{i,relative} * k, \text{ where k = scale range of performance evaluation}$$

The origin coordinates for determining the axis of the original IPA can be seen in the formula below. The results table from the analysis can be seen in the Appendix E.

Origin Coordinates =[(Mean of ($W_{i,relative}$) ; Mean (P_i)]

It was evident that that the cyber security dimension and element (i =42) was an extreme outlier due to the fact that the security dimension was seen overall as a very important aspect and the dimension only contained one element. This caused to the element to be an extreme outlier in the mapping of the data. This can be seen in the figure below. The figure below is only used to indicate the outlier effect; thus, it has less detail than the other figures that follow. The cyber security elements' importance relative to the other elements, which share a dimension with others was so large that it completely skewed the data. It is therefore decided that the cyber security element is removed with regards to the business' overall IPA. It is important to note that the security and cyber security have extremely high weightings with regards to importance within the model and is evaluated in combination with the business readiness evaluation at the end of the chapter. Thus, the business should always invest the appropriate effort and resources towards this readiness dimension and element. The recalculated results table can be seen in Appendix F and the illustrative results are indicated in Figure 81. This is followed by the illustrative results of the IPA (3 weightings) from a strategy, operational and tactical perspective. These perspectives incorporate only the dimensional weightings for operations, tactics and strategy, the overall IPA analysis includes an overall weighting which is determined by including the strategy, tactical and operational weightings.

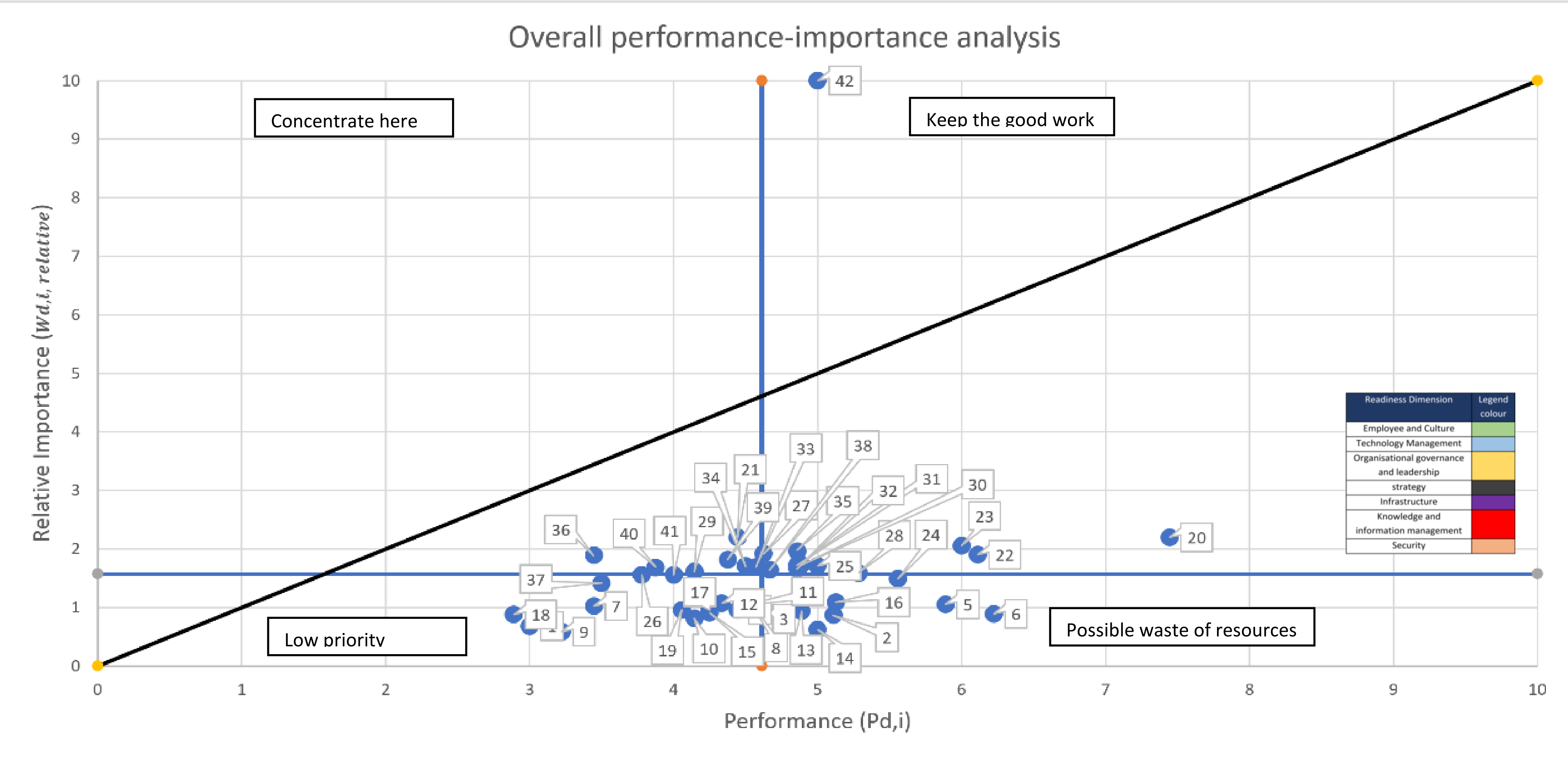

Figure 80. Skewed Overall IPA graph

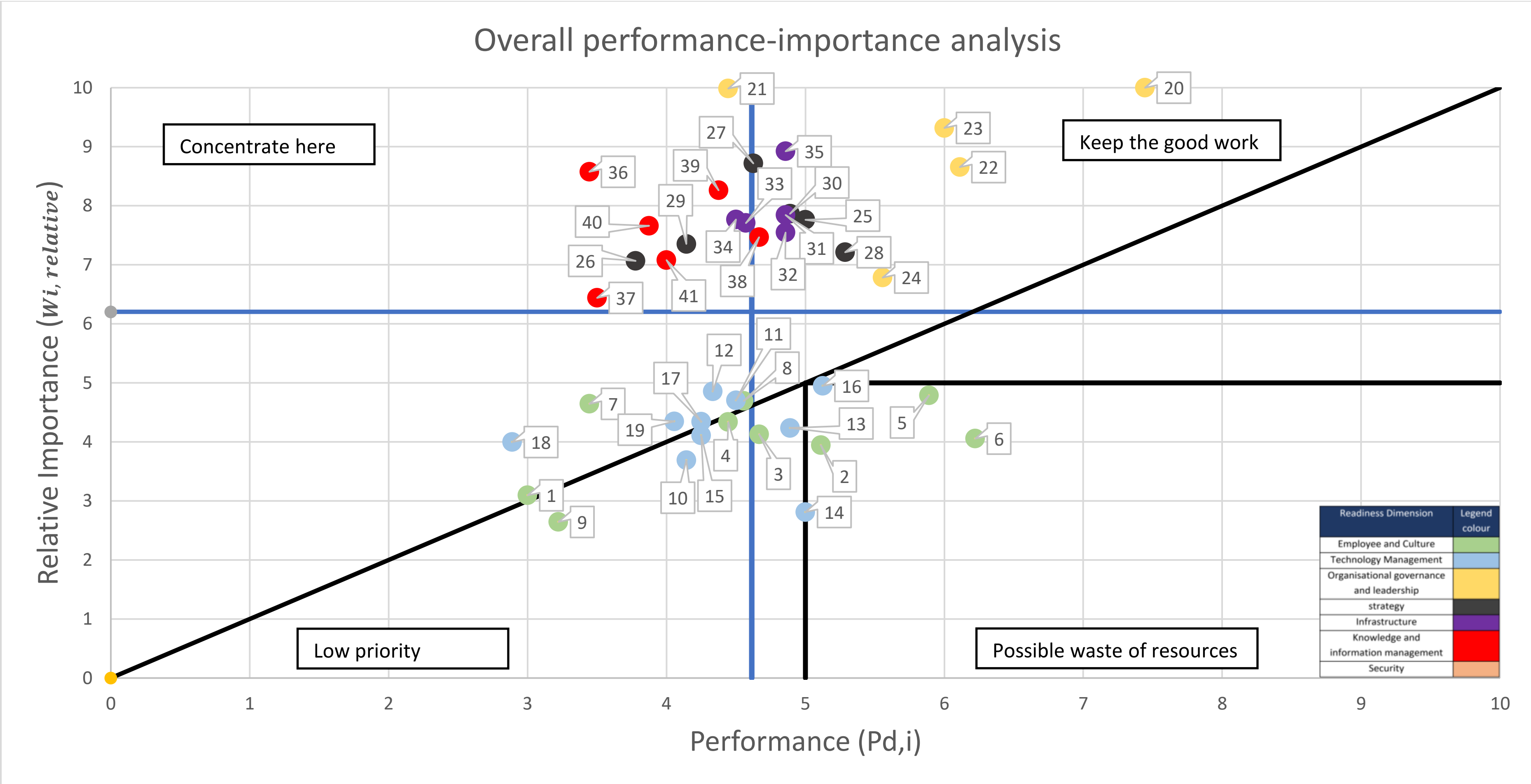

Figure 81. Overall IPA graph

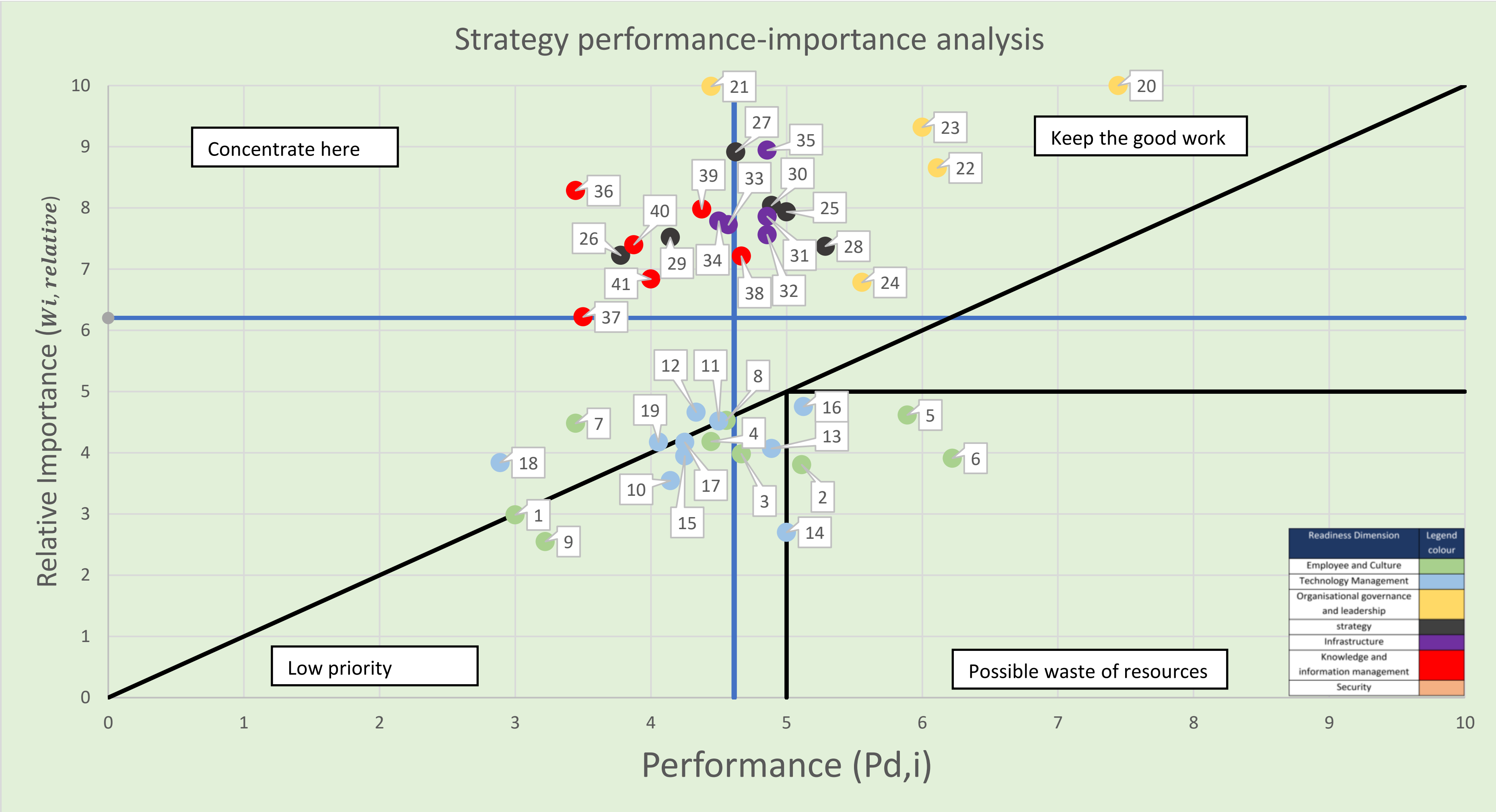

Figure 82. Strategy IPA graph

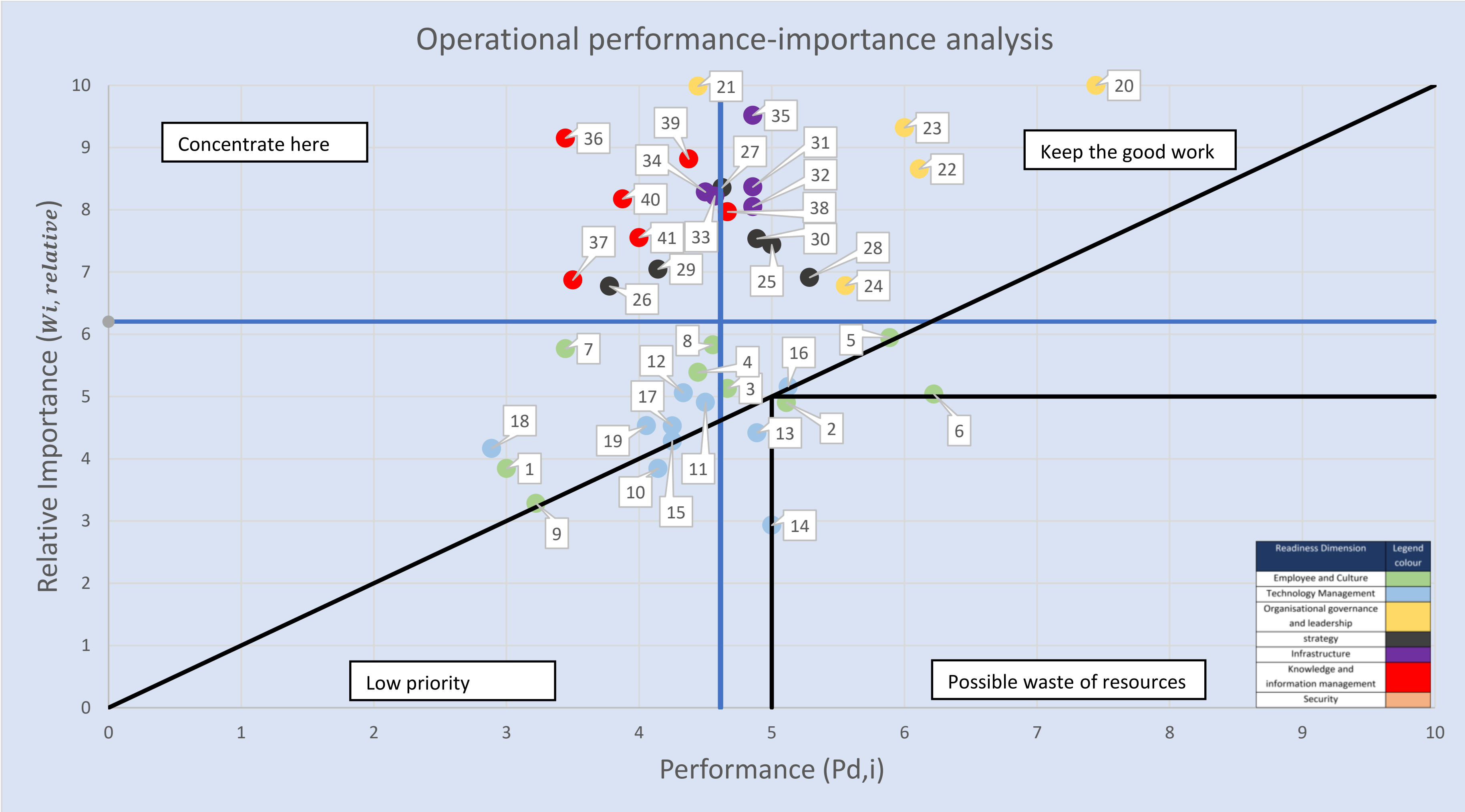

Figure 83. Operational IPA graph

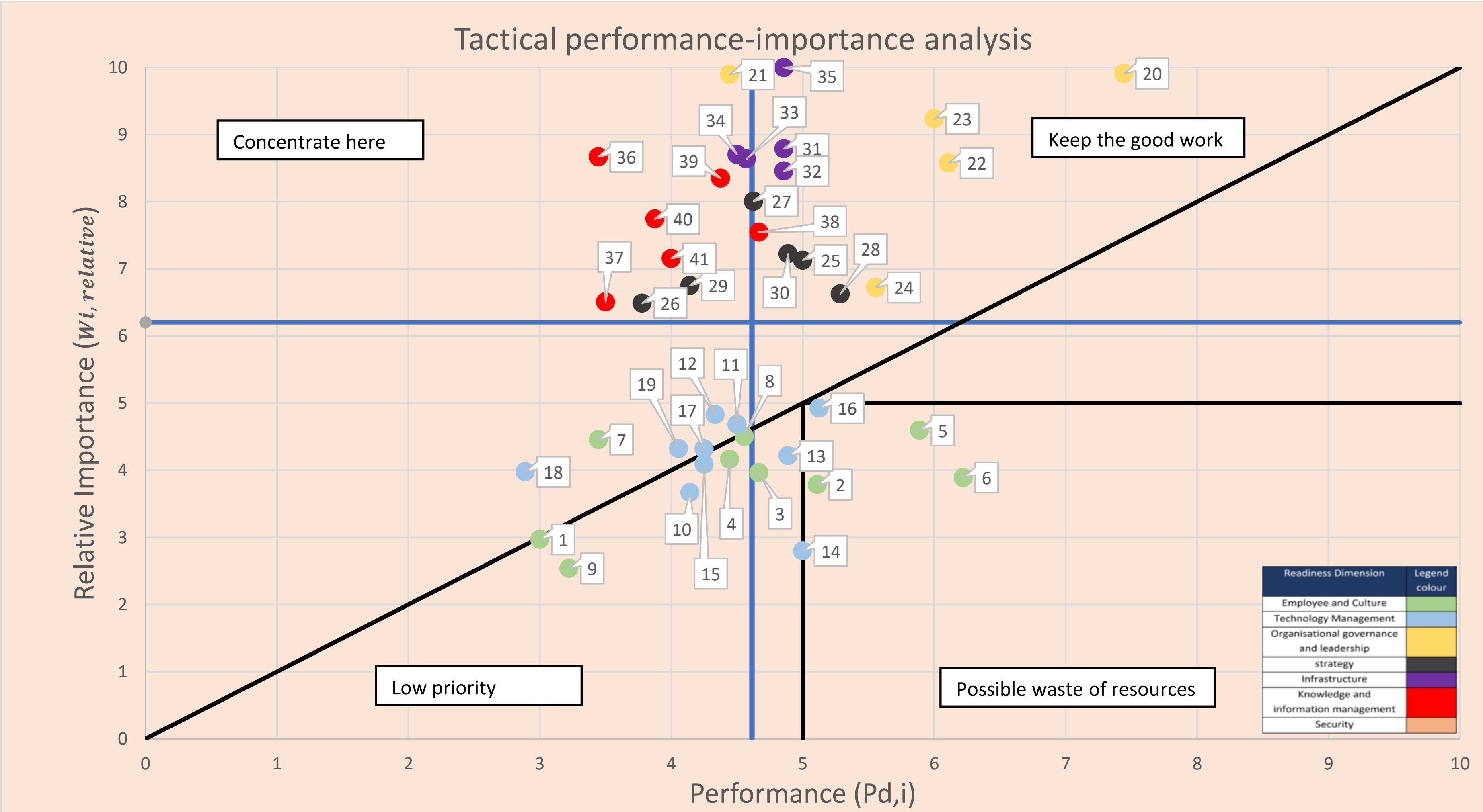

Figure 84. Tactical IPA graph

Overall IPA Results

The first IPA lens that will be focused on is the overall IPA result, which incorporates three weighting levels, as well as the result of incorporating the strategic, operational and tactical weightings to form the overall dimensional weighting. Again, we utilise two interpretation methods, namely the diagonal line method and the empirical mean method, the first focus will be the diagonal line method, followed by the original mean axis method.

The diagonal line method perspective classifies the readiness elements into four areas. These areas are low priority, possible waste of resources, keep up the good work and areas to improve, as well as identifies the elements that are well-balanced through their discrepancy distance from the diagonal line. Looking at the discrepancies with regards to business dimensions in Figure 81, it can be concluded that the employee and culture, as well as the technology management dimensions are better balanced than the other dimensions, seeing as their groupings are more closely following the diagonal line. From this it can be concluded that these dimensions do not require immediate attention from the business, but should be maintained as is until total readiness. The other dimensions all have pretty large discrepancies, thus more attention and resources should be allocated to each of the readiness dimensions. This provides the business with the ability to prioritize their future efforts. The results can be seen in the table below.

Table 53. Overall IPA results

	i	Readiness elements	IPA Diagonal line method classification	IPA Original mean axis method classification
Employee and culture	1	Job Security	Improve here	Low priority
	2	Perceived usefulness	Waste of resources	Waste of resources
	3	Perceived ease of use	Low priority	Waste of resources
	4	Compatibility with existing values and practices	Low priority	Lower priority
	5	Benefits	Waste of resources	Waste of resources
	6	Business Acceptance	Waste of resources	Waste of resources
	7	Skills and expertise	Improve here	Lower priority
	8	Collaboration	Improve here	Lower priority
	9	Certainty	Low priority	Lower priority

Technology Management	10	Technological categorization and planning	Low priority	Lower priority
	11	Technology requirement handling	Improve here	Lower priority
	12	Technological investment and capital management	Improve here	Lower priority
	13	Cost management	Low priority	Waste of resources
	14	Technological competitors' analysis	Low priority	Waste of resources
	15	Cloud resources	Low priority	Lower priority
	16	Network Connectivity	Waste of resources	Waste of resources
	17	Technology Risk Management	Improve here	Lower priority
	18	Quality Management	Improve here	Lower priority
	19	Human resource planning	Improve here	Lower priority
Organizational governance and leadership	20	Executive support	Improve here	Keep up the good work
	21	Budget	Improve here	Concentrate here
	22	Business opportunity	Improve here	Keep up the good work
	23	Strategic leadership	Improve here	Keep up the good work
	24	Business cases	Improve here	Keep up the good work
Strategy	25	Trial-ability	Improve here	Keep up the good work
	26	Business clarity	Improve here	Concentrate here
	27	Observable results	Improve here	Keep up the good work
	28	Technology roadmaps and scenarios	Improve here	Keep up the good work
	29	Technology prospect/forecasting	Improve here	Concentrate here
	30	Agile delivery	Improve here	Keep up the good work

Infrastructure	31	Technologic sustainability and position map	Improve here	Keep up the good work
	32	Communication networks	Improve here	Concentrate here
	33	Information networks	Improve here	Concentrate here
	34	Services	Improve here	Concentrate here
	35	Infrastructure platform	Improve here	Keep up the good work
Knowledge and information management	36	Management information system and data processing	Improve here	Concentrate here
	37	Agent based applications	Improve here	Concentrate here
	38	Return on investment	Improve here	Keep up the good work
	39	Enterprise resource planning in terms of databases and software	Improve here	Concentrate here
	40	Technology knowledge management	Improve here	Concentrate here
	41	Technology identification and selection	Improve here	Concentrate here

From Table 53. The business should shift their immediate focus towards the "concentrate here" readiness elements, while maintaining resources and efforts towards the "keep up the good work" readiness elements. The business should start further investigating whether the readiness elements in the "waste of resources" require the current resources that are being used for it.

From the diagonal line method perspective one can conclude that the readiness elements with the lowest discrepancies are well balanced elements with regards to close to equal performance with regards to importance. From the overall IPA graph, we can identify the low discrepancy elements, as elements that are close to the 45-degree angle line in the graph. The list of elements identified as balanced elements with regards to the developed relative weightings. These identified elements are:

Table 54. Overall IPA well balanced readiness elements

i	Readiness elements (i)	IPA classification
1	Job Security	Well balanced
19	Human resource planning	Well balanced
15	Cloud resources	Well balanced
17	Technology Risk Management	Well balanced
4	Compatibility with existing values and practices	Well balanced
8	Collaboration	Well balanced
11	Technology requirement handling	Well balanced
16	Network Connectivity	Well balanced

Looking at Table 53, using a long term strategic perspective, with regards to the diagonal line method, it can be concluded that the overall readiness for artificial intelligence is low, due to that 4 readiness dimensions' elements are all categorized as "improve here", thus the performance is lower than the importance across the four dimensions. The technology management and employee and governance dimension have a balance of "low priority", "waste of resources" and "improve here" categorized elements., thus these are categorized as lower priority with regards to the long-term focus. The overall consensus shows that the long-term strategy with regards to readiness, is that the business needs to focus towards improving most of these readiness dimensions and elements.

With this in mind we shift towards the short to medium strategic focus and prioritization. For this focus, the original axis method, which implements the empirical means to determine the axis' origin, one could prioritize the sections of readiness elements into 4 four sections, as well as illustratively identifying readiness dimensions interpretations. These 4 four sections are "concentrate here", "keep up the good work", "low priority" and "possible waste of resources". With regards to the readiness dimensions, the organisational governance and leadership, strategy and infrastructure dimensions are performing well, as most of the elements reside in the "keep up the good work" section. There is a strong grouping of knowledge and information management elements in the "concentrate here" section, thus the organization should shift their attention and resources towards the development and improvement of these dimension. Currently the technology management dimension and employee and culture are overall seen as a lower priority dimensions, due to its grouping elements in the "low priority" and "waste of resources" sections. Seeing as we have categorized and prioritized the overall readiness dimensions, the next focus is grouping the elements according to their quadrants. In Table 55 the readiness dimensions are categorized as a result of their overall element categorization, thus the employee and culture and technology management dimensions are "low priority" and indicated with a blue colour. The organizational governance and leadership and strategy dimension are overall categorized as "keep up the good work" and is indicated with the colour green. The infrastructure and knowledge and information management dimensions are overall categorized as "concentrate here" and is indicated with a red colour. Seeing as the dimensions have been categorized and prioritized, the next steps is prioritizing the readiness elements within each dimension. This is done by prioritizing the highest to lowest difference in the performance vs the goal/importance for each element. The results can be seen in the table below.

Table 55. Summary of overall IPA results from original mean axis method

Readiness Dimension	i	Readiness element	Wd,i	Relative Wi	Pd,i	Goal	Performance -goal difference	Quadrant
Employee and Culture	7	Skills and expertise	0.10735	4.6442	3.4444	4.64	-1.1956	Lower priority
	8	Collaboration	0.10849	4.6936	4.5555	4.69	-0.1345	Lower priority
	1	Job Security	0.0715	3.0948	3	3.09	-0.09	Low priority
	4	Compatibility with existing values and practices	0.10027	4.3379	4.4444	4.34	0.1044	Lower priority
	3	Perceived ease of use	0.09544	4.129	4.6666	4.13	0.5366	Waste of resources
	9	Certainty	0.06111	2.644	3.2222	2.64	0.5822	Lower priority
	5	Benefits	0.11065	4.7869	5.8888	4.79	1.0988	Waste of resources
	2	Perceived usefulness	0.0911	3.945	5.1111	3.95	1.1611	Waste of resources
	6	Business Acceptance	0.09373	4.0553	6.2222	4.06	2.1622	Waste of resources
Technology Management	18	Quality Management	0.08795	3.997	2.8888	4	-1.1112	Lower priority
	12	Technological investment and capital management	0.10679	4.8538	4.3333	4.85	-0.5167	Lower priority
	19	Human resource planning	0.09565	4.3473	4.0555	4.35	-0.2945	Lower priority
	11	Technology requirement handling	0.10353	4.7057	4.5	4.71	-0.21	Lower priority
	17	Technology Risk Management	0.09554	4.3426	4.25	4.34	-0.09	Lower priority
	15	Cloud resources	0.09042	4.1099	4.25	4.11	0.14	Lower priority
	16	Network Connectivity	0.10888	4.949	5.125	4.95	0.175	Waste of resources
	10	Technological categorization and planning	0.08115	3.6884	4.1428	3.69	0.4528	Lower priority
	13	Cost management	0.09322	4.2368	4.8888	4.24	0.6488	Waste of resources

	14	Technological competitors' analysis	0.06187	2.8123	5	2.81	2.19	Waste of resources
Organizational governance and leadership	**21**	Budget	0.21998	9.9855	4.4444	9.99	-5.5456	Concentrate here
	23	Strategic leadership	0.20528	9.3184	6	9.32	-3.32	Keep up the good work
	20	Executive support	0.2203	10	7.4444	10	-2.5556	Keep up the good work
	22	Business opportunity	0.19066	8.6546	6.1111	8.65	-2.5389	Keep up the good work
	24	Business cases	0.14944	6.7835	5.5555	6.78	-1.2245	Keep up the good work
Strategy	**27**	Observable results	0.18696	8.7176	4.625	8.72	-4.095	Keep up the good work
	26	Business clarity	0.1515	7.06573	3.7777	7.07	-3.2923	Concentrate here
	29	Technology prospect/forecasting	0.15769	7.3531	4.1428	7.35	-3.2072	Concentrate here
	30	Agile delivery	0.16867	7.8648	4.8888	7.86	-2.9712	Keep up the good work
	25	Trial-ability	0.16647	7.7623	5	7.76	-2.76	Keep up the good work
	28	Technology roadmaps and scenarios	0.15468	7.2125	5.2857	7.21	-1.9243	Keep up the good work
Infrastructure	**35**	Infrastructure platform	0.20869	8.9225	4.8571	8.92	-4.0629	Keep up the good work
	33	Information networks	0.18025	7.70665	4.5714	7.71	-3.1386	Concentrate here

	31	Technologic sustainability and position map	0.18344	7.843	4.8571	7.84	-2.9829	Keep up the good work
	32	Communication networks	0.1765	7.5465	4.8571	7.55	-2.6929	Keep up the good work
	34	Services	0.18166	7.76693	4.5	7.77	-3.27	Concentrate here
Knowledge and information management	**36**	Management information system and data processing	0.1914	8.5757	3.4444	8.58	-5.1356	Concentrate here
	39	Enterprise resource planning in terms of databases and software	0.18442	8.2621	4.375	8.26	-3.885	Concentrate here
	40	Technology knowledge management	0.1701	7.66092	3.875	7.66	-3.785	Concentrate here
	41	Technology identification and selection	0.158	7.07907	4	7.08	-3.08	Concentrate here
	37	Agent based applications	0.14372	6.439	3.5	6.44	-2.94	Concentrate here
	38	Return on investment	0.16666	7.4669	4.6666	7.47	-2.8034	Keep up the good work
	42	Cyber security	1	/	5	/		/

When looking at the table above we have categorized employee and culture and technology management as lower priority dimensions, within each of these dimensions the highest priority elements are identified in the table below

Table 56. Three highest priority elements in "low priority" readiness dimensions

Employee and culture	Technology Management
Skills and expertise	Quality Management
Collaboration	Technological investment and capital management
Job security	Human resource planning

The Infrastructure, Strategy and Organizational governance and leadership dimensions have been identified as well performing dimensions, but keeping in mind the long-term strategy improvement need. These readiness dimensions still require improvements, thus the three highest priority elements within these readiness dimensions are shown in the table below.

Table 57. Three highest priority elements in "keep up the good work" readiness dimensions

Strategy	Organizational governance and leadership	Infrastructure
Observable results	Budget	Infrastructure platform
Business clarity	Strategic leadership	Information networks
Technology prospect/forecasting	Executive support	Technologic sustainability and position map

The infrastructure and knowledge and information management dimensions have been identified as dimensions that require the most attention and highest prioritization. The three highest priority elements within these readiness dimensions are shown in the table below.

Table 58. Three highest priority elements in "Concentrate here" readiness dimension

Knowledge and information management
Management information system and data processing
Enterprise resource planning in terms of databases and software
Technology knowledge management

In conclusion with regards to the overall IPA analysis, incorporation of three weighting factors and two interpretation methods, it can be deduced that the long term aim of the business should be the improvement of the strategy, infrastructure, knowledge and information management, organizational management dimensions, whereas the technology management and employee and culture dimensions require attention, but are seen as relatively lower priority dimensions. With this in mind the short to medium term aim with regards to these readiness dimensions are divided into overall three categories. This can be seen in Table 56, Table 57 and Table 58. The most important focus is the knowledge and information management dimension, as these dimensions are underperforming and has been identified as important dimensions. This focus is further refined by identifying the readiness elements within each of these dimensions that have the highest difference between performance and importance. The improvement of these elements could provide large increases in readiness, due to their importance. These elements can be seen in Table 58. The next section is calculated/developed to assist the business in providing the categorization and prioritization of readiness dimensions and elements from three perspectives. These perspectives are strategic, operational and tactical.

Strategy, operational and tactical IPA

The second IPA lens that will be focused on is the results obtained from the IPA using dimensional weightings of strategy, operations and tactics. There are two interpretation methods, namely the diagonal line method and the empirical mean method, the first focus will be the diagonal line method, followed by the original mean axis method. The diagonal line method interpretation results will be shown in comparison to the different dimensional weightings. The diagonal line method categorizes the readiness element into four categories as seen in Figure 71. The results can be seen in the table below.

Table 59. Strategic, operational and tactical IPA diagonal method results

Readiness Dimension	**i**	business cases	Strategic IPA classification	Operational IPA classification	Tactical IPA classification
Employee and Culture	**1**	Job Security	Improve here	Improve here	Low priority
	2	Perceived usefulness	Waste of resources	Waste of resources	Waste of resources
	3	Perceived ease of use	Low priority	Improve here	Low priority
	4	Compatibility with existing values and practices	Low priority	Improve here	Low priority
	5	Benefits	Waste of resources	Improve here	Waste of resources

	6	Business acceptance	Waste of resources	Keep up the good work	Waste of resources
	7	Skills and expertise	Improve here	Improve here	Improve here
	8	Collaboration	Low priority	Improve here	Low priority
	9	Certainty	Low priority	Improve here	Low priority
Technology Management	10	Technological categorization and planning	Low priority	Low priority	Low priority
	11	Technology requirement handling	Improve here	Improve here	Improve here
	12	Technological investment and capital management	Improve here	Improve here	Improve here
	13	Cost management	Low priority	Low priority	Low priority
	14	Technological competitors' analysis	Low priority	Low priority	Low priority
	15	Cloud resources	Low priority	Improve here	Low priority
	16	Network Connectivity	Waste of resources	Improve here	Waste of resources
	17	Technology Risk Management	Low priority	Improve here	Improve here
	18	Quality Management	Improve here	Improve here	Improve here
	19	Human resource planning	Improve here	Improve here	Improve here
Organizational Governance and Leadership	20	Executive support	Improve here	Improve here	Improve here
	21	Budget	Improve here	Improve here	Improve here
	22	Business opportunity	Improve here	Improve here	Improve here
	23	Strategic leadership	Improve here	Improve here	Improve here
	24	Business cases	Improve here	Improve here	Improve here
Strategy	25	Trial-ability	Improve here	Improve here	Improve here
	26	Business clarity	Improve here	Improve here	Improve here

	27	Observable results	Improve here	Improve here	Improve here
	28	Technology roadmaps and scenarios	Improve here	Improve here	Improve here
	29	Technology prospect/forecasting	Improve here	Improve here	Improve here
	30	Agile delivery	Improve here	Improve here	Improve here
Infrastructure	**31**	Technologic sustainability and position map	Improve here	Improve here	Improve here
	32	Communication networks	Improve here	Improve here	Improve here
	33	Information networks	Improve here	Improve here	Improve here
	34	Services	Improve here	Improve here	Improve here
	35	Infrastructure platform	Improve here	Improve here	Improve here
Knowledge and information management	**36**	Management information system and data processing	Improve here	Improve here	Improve here
	37	Agent based applications	Improve here	Improve here	Improve here
	38	Return on investment	Improve here	Improve here	Improve here
	39	Enterprise resource planning in terms of databases and software	Improve here	Improve here	Improve here
	40	Technology knowledge management	Improve here	Improve here	Improve here
	41	Technology identification and selection	Improve here	Improve here	Improve here

From the results above. The business should shift their immediate focus towards the "Improve here" readiness elements, while maintaining resources and efforts towards the "keep up the good work" readiness elements. The business should start further investigating whether the readiness elements in the "waste of resources" require the current resources that are being used for it. The table provides a unique view in terms of indicating the categorized elements, as well as the results when focusing on strategy, operations or tactics, thus if the business wants a strategic focus with regards to these readiness elements, it can view above. The next IPA focus is applying the original axis method, to these data points. The results can be seen in the table below.

Table 60. Strategic, operational and tactical IPA original axis method results

Readiness Dimension	i	Readiness elements (i)	IPA Strategy	IPA Operational	IPA Tactical
Employee and Culture	**1**	Job Security	Low Priority	Low Priority	Low Priority
	2	Perceived usefulness	Possible waste of resources	Possible waste of resources	Possible waste of resources
	3	Perceived ease of use	Possible waste of resources	Possible waste of resources	Possible waste of resources
	4	Compatibility with existing values and practices	Low Priority	Low Priority	Low Priority
	5	Benefits	Possible waste of resources	Possible waste of resources	Possible waste of resources
	6	Business acceptance	Possible waste of resources	Possible waste of resources	Possible waste of resources
	7	Skills and expertise	Low Priority	Low Priority	Low Priority
	8	Collaboration	Low Priority	Low Priority	Low Priority
	9	Certainty	Low Priority	Low Priority	Low Priority
Technology Management	**10**	Technological categorization and planning	Low Priority	Low Priority	Low Priority
	11	Technology requirement handling	Low Priority	Low Priority	Low Priority
	12	Technological investment and capital management	Low Priority	Low Priority	Low Priority
	13	Cost management	Possible waste of resources	Possible waste of resources	Possible waste of resources
	14	Technological competitors' analysis	Possible waste of resources	Possible waste of resources	Possible waste of resources
	15	Cloud resources	Low Priority	Low Priority	Low Priority

	16	Network connectivity	Possible waste of resources	Possible waste of resources	Possible waste of resources
	17	Technology risk management	Low Priority	Low Priority	Low Priority
	18	Quality management	Low Priority	Low Priority	Low Priority
	19	Human resource planning	Low Priority	Low Priority	Low Priority
Organizational Governance and Leadership	20	Executive support	Keep up the good work	Keep up the good work	Keep up the good work
	21	Budget	Concentrate here	Concentrate here	Concentrate here
	22	Business opportunity	Keep up the good work	Keep up the good work	Keep up the good work
	23	Strategic leadership	Keep up the good work	Keep up the good work	Keep up the good work
	24	Business cases	Keep up the good work	Keep up the good work	Keep up the good work
Strategy	25	Trial-ability	Keep up the good work	Keep up the good work	Keep up the good work
	26	Business clarity	Concentrate here	Concentrate here	Concentrate here
	27	Observable results	Keep up the good work	Concentrate here/Keep up the good work	Concentrate here/Keep up the good work
	28	Technology roadmaps and scenarios	Keep up the good work	Keep up the good work	Keep up the good work
	29	Technology prospect/forecasting	Concentrate here	Concentrate here	Concentrate here
	30	Agile delivery	Keep up the good work	Keep up the good work	Keep up the good work
Infrastructure	31	Technologic sustainability and position map	Keep up the good work	Keep up the good work	Keep up the good work
	32	Communication networks	Keep up the good work	Keep up the good work	Keep up the good work
	33	Information networks	Concentrate here	Concentrate here	Concentrate here
	34	Services	Concentrate here	Concentrate here	Concentrate here

	35	Infrastructure platform	Keep up the good work	Keep up the good work	Keep up the good work
Knowledge and information management	**36**	Management information system and data processing	Concentrate here	Concentrate here	Concentrate here
	37	Agent based applications	Concentrate here	Concentrate here	Concentrate here
	38	Return on investment	Keep up the good work	Keep up the good work	Keep up the good work
	39	Enterprise resource planning in terms of databases and software	Concentrate here	Concentrate here	Concentrate here
	40	Technology knowledge management	Concentrate here	Concentrate here	Concentrate here
	41	Technology identification and selection	Concentrate here	Concentrate here	Concentrate here
	42	Cyber security	-	-	-

These graphs provide some useful insights into the business with regards to where the business is doing well, possibly wasting resources, identification of lower priority elements, as well as where the business needs to focus future prioritization, assets and effort to greatly improve the business' overall readiness for the implementation of artificial intelligence. The strategic, operational and tactical views provide different perspectives on what elements are important, require attention and where resources are possibly wasted. These can be identified through 4 different generated perspectives in terms of models the model weightings seen in the list below:

- Overall (combination of strategy, operations and tactics) importance-performance analysis results including three weightings factors (readiness dimension, element and variable weightings)
- Importance-performance analysis of strategy including three weightings factors (readiness dimension, element and variable weightings)
- Importance-performance analysis of operations including three weightings factors (readiness dimension, element and variable weightings)
- Importance-performance analysis of tactics including three weightings factors (readiness dimension, element and variable weightings)

Each of the views have two interpretation methods have integrated into each graph. These being the original means IPA axis and the diagonal line method. These should provide the user with multiple views and interpretation of the data gathered. This also encompasses the categorization and prioritization of readiness dimensions and elements. The next phase is identifying the business' readiness evaluation results. To identify high and low performing readiness dimensions and elements.

7.4 Business readiness index

The previous section assists the business in the categorization and prioritizing of readiness dimensions and elements. The readiness index section will indicate the business' readiness numerically. The surveys in the model are used to determine the weightings and maturity of an item. The readiness level of each dimension ($\boldsymbol{R_d}$) is determined by calculating the weighted average of all the readiness elements' performance ($\boldsymbol{P_{d,i,n}}$) within each dimension. This is done by using the calculations as seen below.

$$R_d = \sum_{l=1}^{i} R_{d,l} . w_{d,l}$$

Where $R_{d,i}$: Performance/readiness of Readiness element

And $w_{d,i}$: Weighting of readiness element

$$R_{d,i} = \sum_{l=1}^{n} P_{d,i,n} . w_{d,i,n}$$

Where $P_{d,i,n}$: Average of performance/satisfaction rating of readiness variable across all respondents

And $w_{d,i,n}$: Readiness variable weight

$$P_{d,i,n} = (\sum_{l=1}^{S} P_{l,d,i,n})/\text{S}$$

Where $P_{d,i,l}$: Performance/satisfaction rating of readiness variable

And S : Number of respondents

The readiness index table developed to determine these readiness evaluations can be seen in Appendix G. The results of the calculation as seen above with regards to the table in Appendix G, can be seen in the figures below. The results regarding the business' overall readiness for AI can be seen in table below and Figure 85. For this business to completely ready, these evaluations' numeric value should be 10.

Table 61. Overall business dimension readiness for artificial intelligence

Readiness dimensions	Rd (Readiness)
Employee and culture	3.87
Technology Management	4.02
Organizational governance and leadership	5.84

Strategy	4.57
Infrastructure	4.4
Knowledge and information management	4.04
Security	5

From the table above, it can be concluded that the top three readiness dimensions are, organizational governance and leadership, security and strategy dimensions, which has the highest performing dimensions with regards to readiness for AI implementation. These results in combination with the previous section will be interpreted in the conclusion of this chapter.

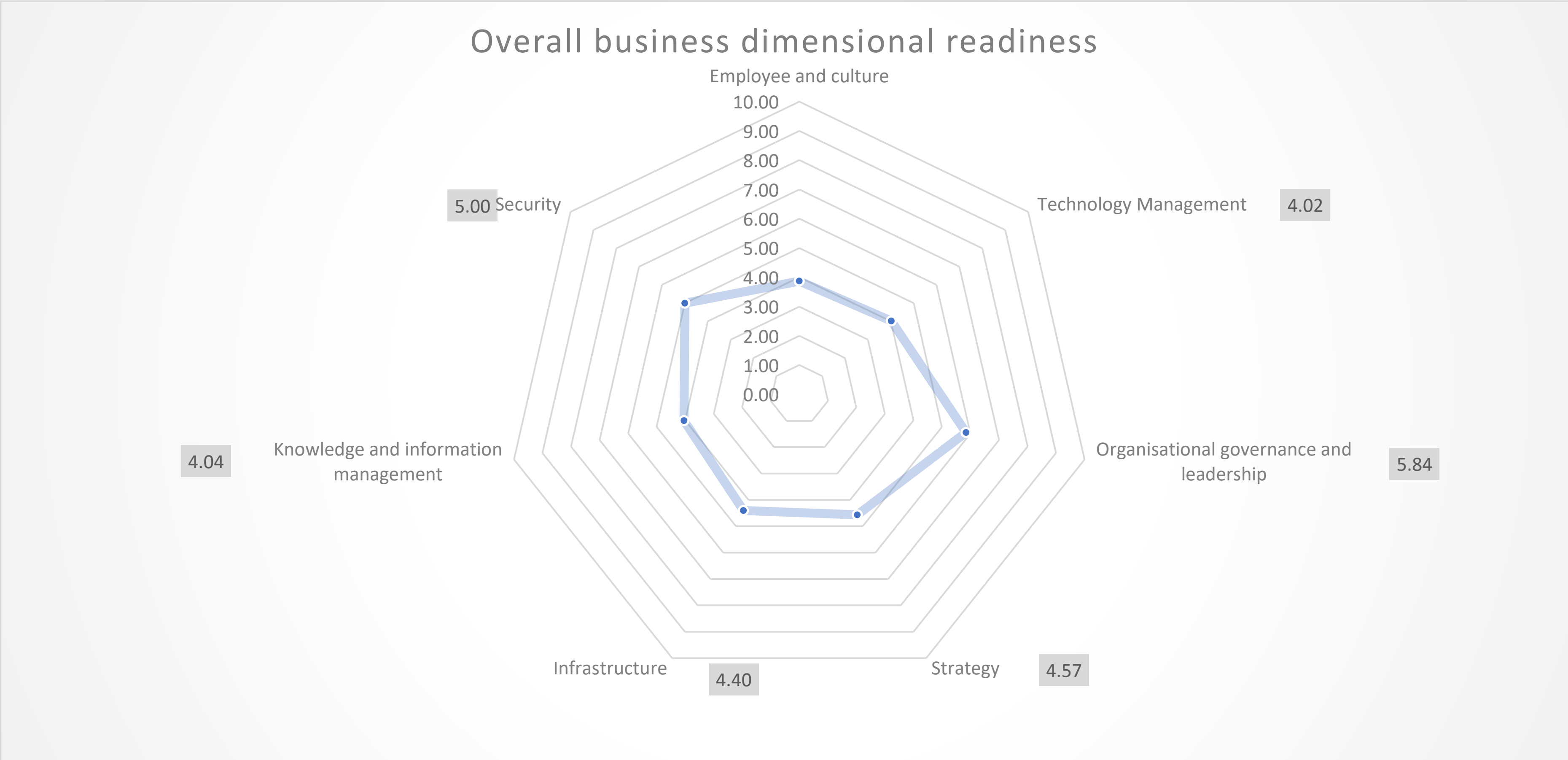

Figure 85. Overall business dimensional readiness

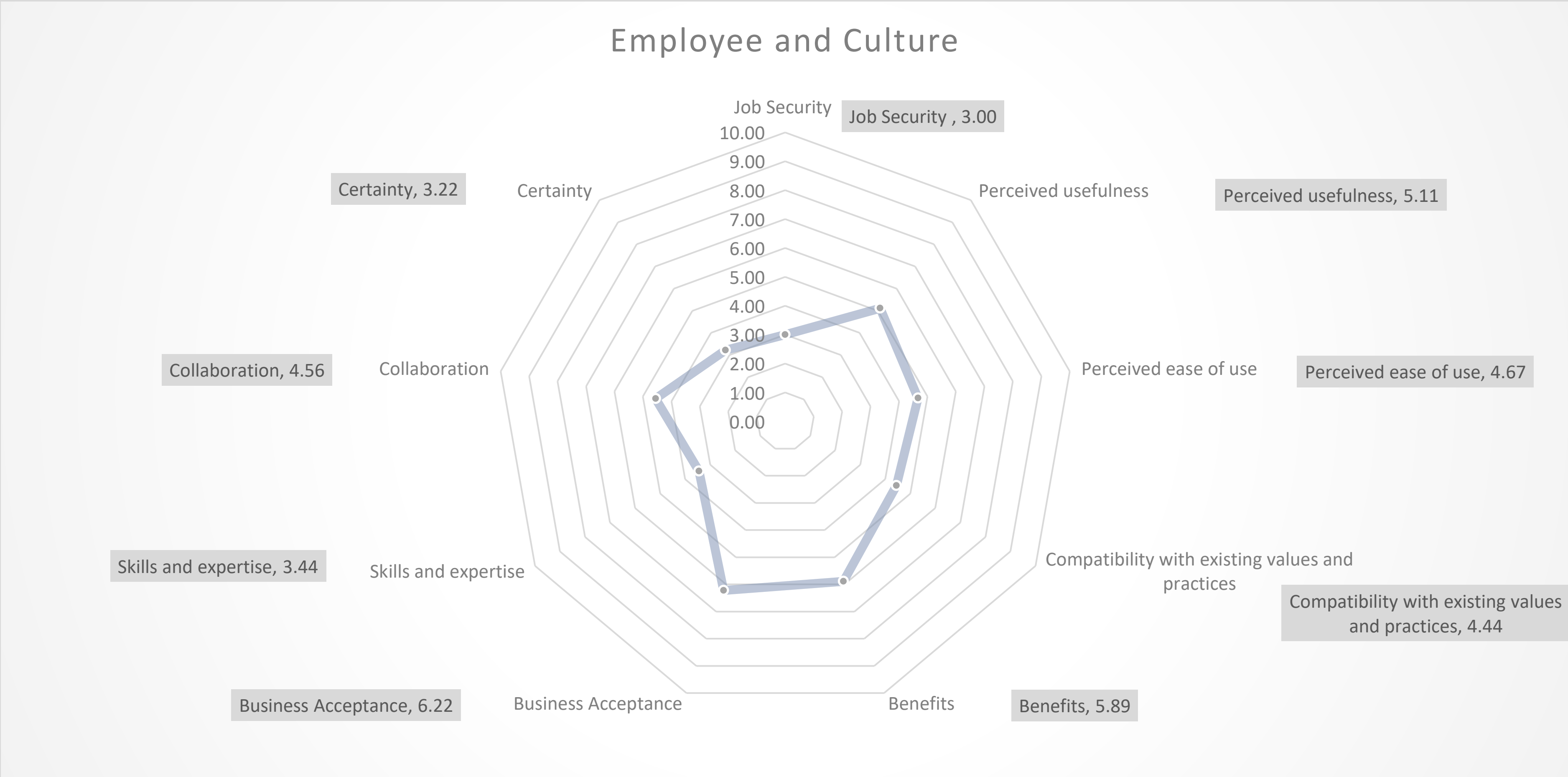

Figure 86. Business readiness within employee and culture dimension

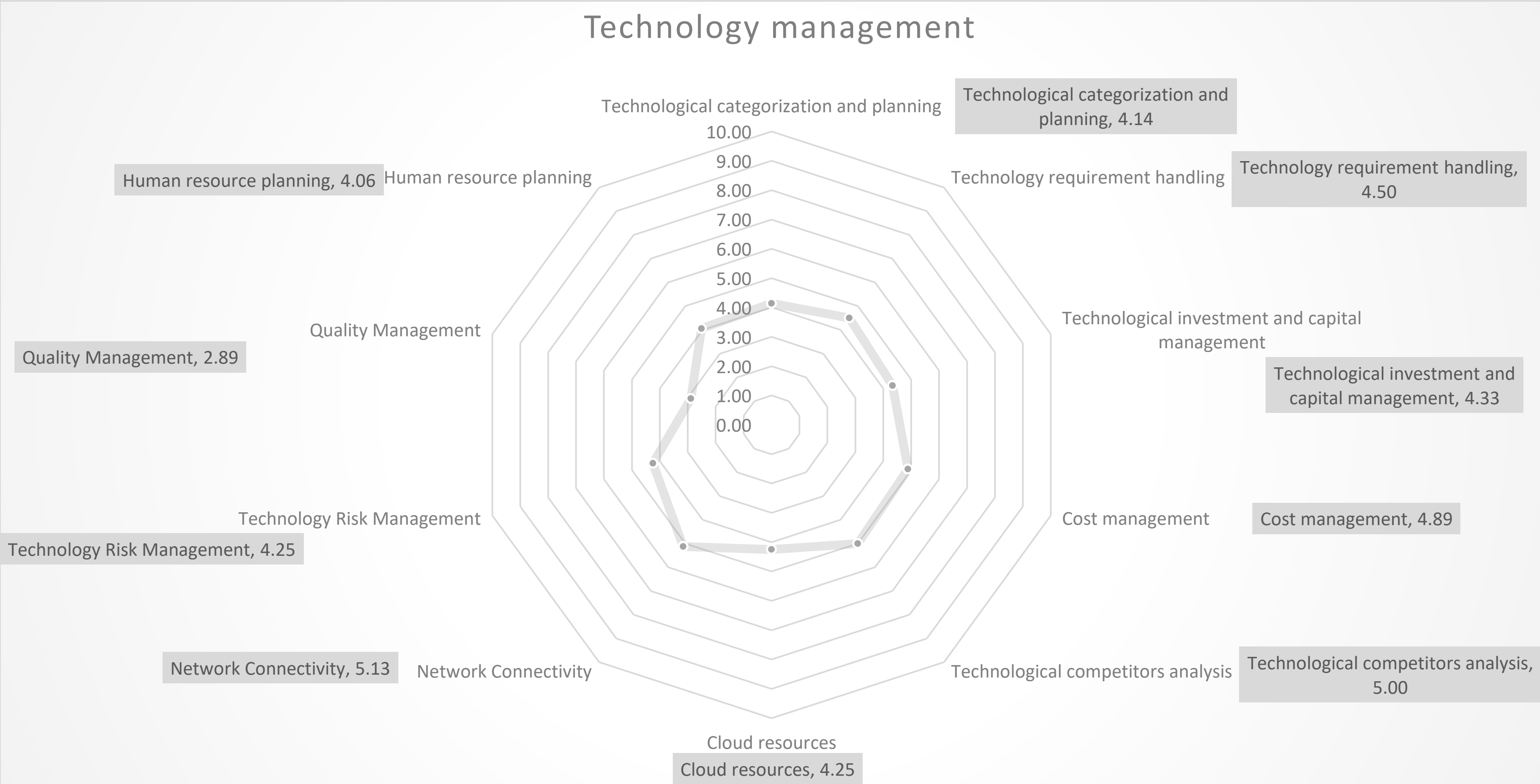

Figure 87. Business readiness within technology management dimension

Figure 88. Business readiness within organisational governance and leadership dimension

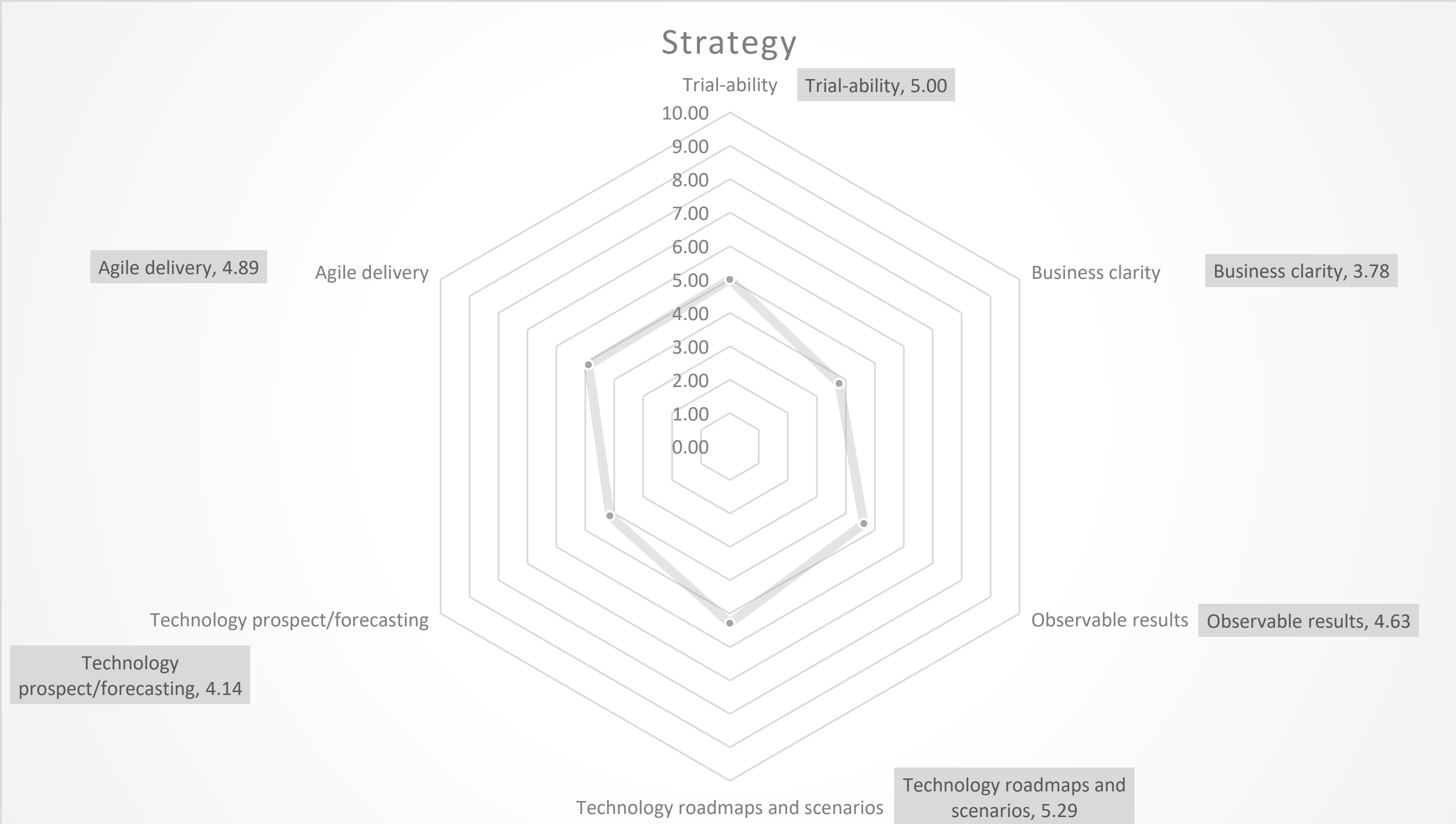

Figure 89. Business readiness within strategy dimension

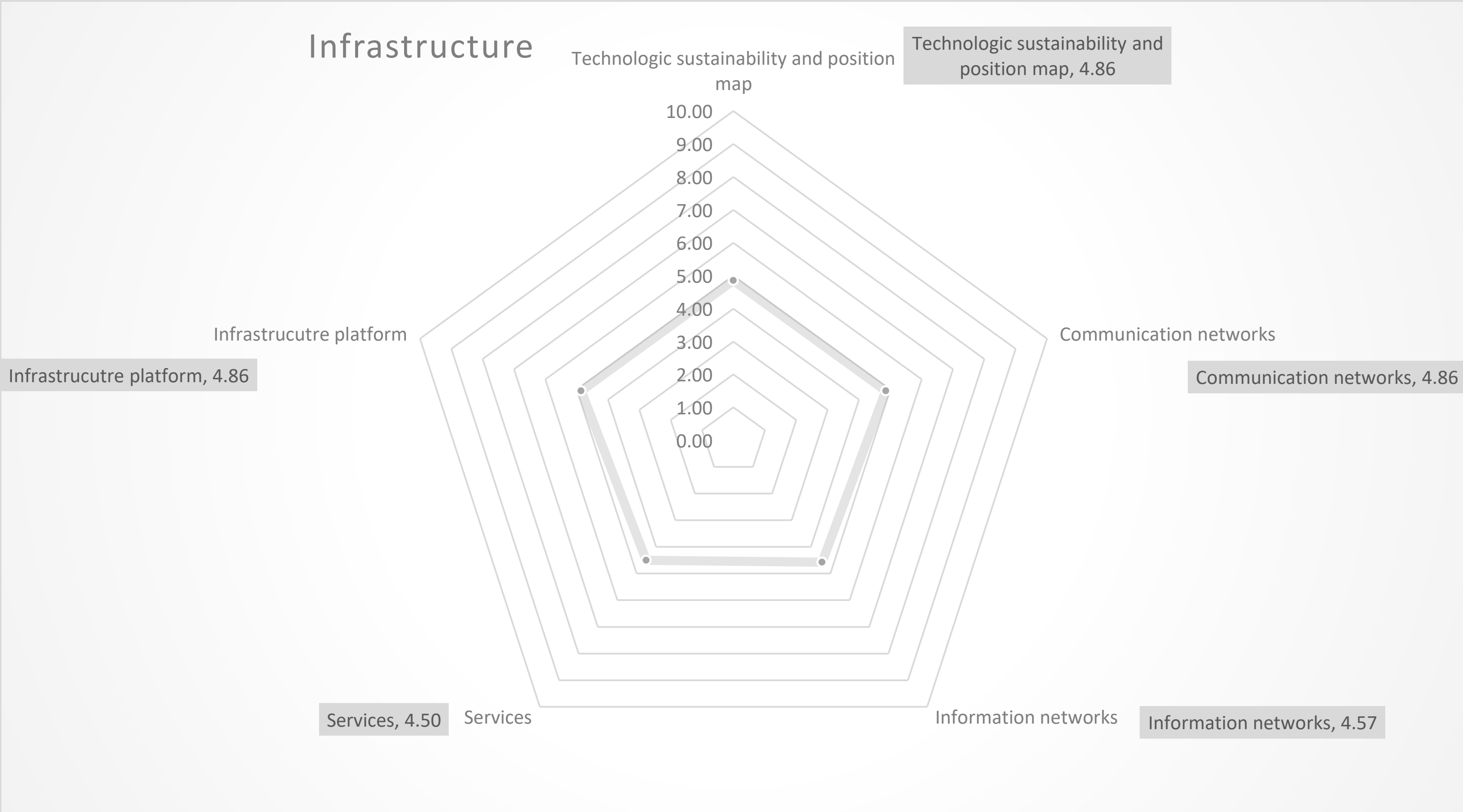

Figure 90. Business readiness within infrastructure dimension

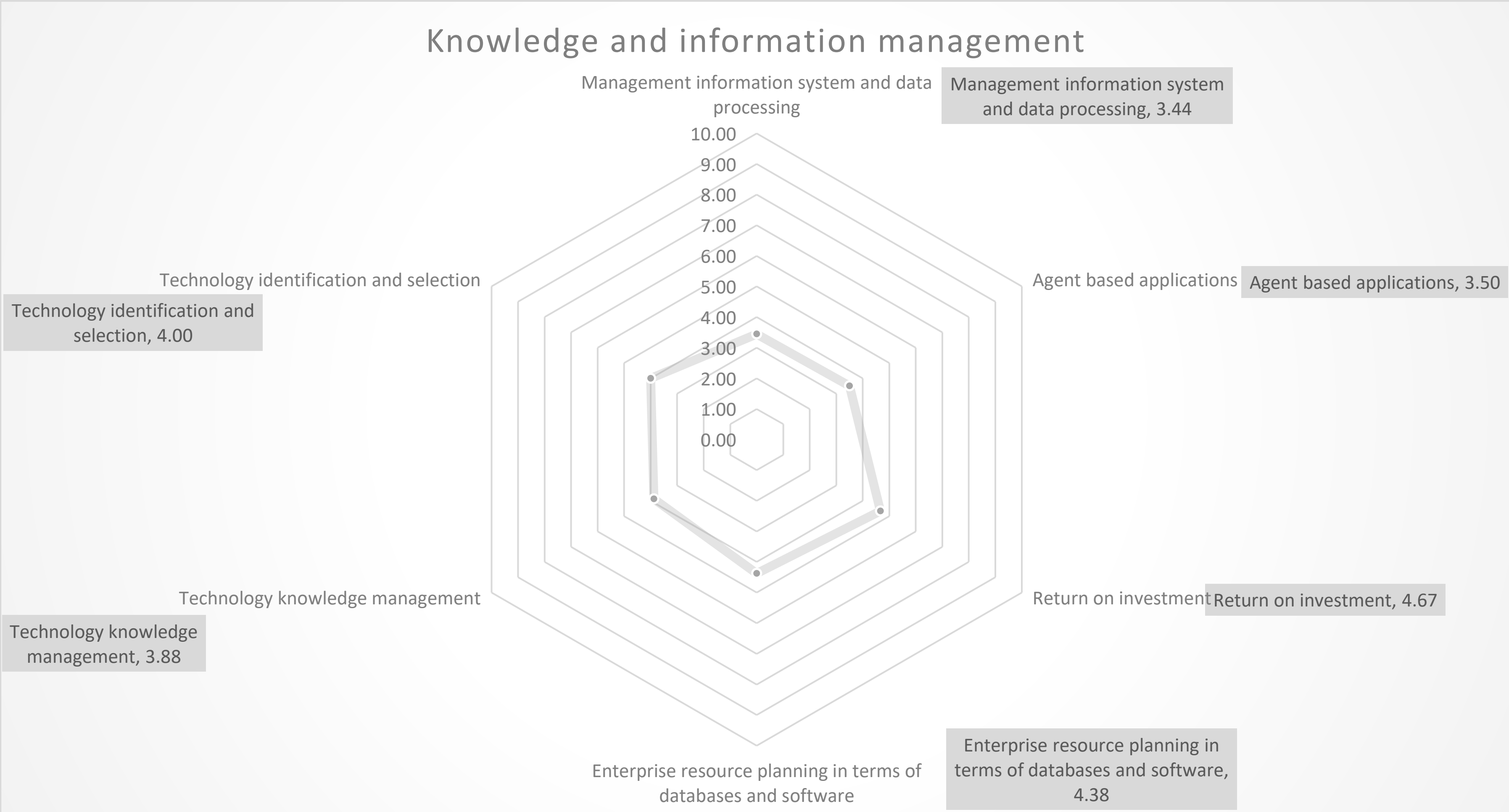

Figure 91. Business readiness within knowledge and information management dimension

The overall consensus with the business performance/maturity with regards to readiness for artificial intelligence, is that the business is not completely ready for the implementation of artificial intelligence. As the highest performing readiness dimension is the organization governance and leadership with a sore of 5.85/10. This supports the long-term strategic view of improvement identified in section 7.3 Overall IPA results.

When viewing these readiness evaluations as seen above from the overall business dimension readiness, the bottom three dimension are Employee and culture (score: 3.87), Technology Management (score: 4.02) and Knowledge and information management (score: 4.04) as seen in Figure 85. In terms of developing a balanced readiness view within each of these dimensions, the employee and culture dimensions' three lowest elements performing elements are skills and expertise (score: 3.44), Certainty (score: 3.22) and job security (score: 3) as seen in Figure 86. Within the technology management dimension, the three lowest elements that require attention are quality management (score: 2.89), human resource planning (score:4.06) and technological categorization and planning (score: 4.14). Within the knowledge and information management dimension, the three lowest performing elements are management information system and data processing (score: 3.45), technology knowledge management (score: 3.88), and agent-based applications (score: 3.5).

From the results indicated above it is clear that the business has still many opportunities to increase its overall readiness for artificial intelligence implementation. The readiness calculations provide insights into the performance of various readiness dimensions and readiness elements from a management point of view, but the importance performance analysis section provides insights into which readiness dimensions and elements need to be addressed first with regards to the project, to facilitate large increases in readiness in the short to medium term of the business.

7.5 Case Study Conclusion

The conclusion starts with focusing on the readiness index and the overall IPA results. Looking at section 7.3, the readiness dimensions: "Infrastructure", "organisational governance and leadership" and "Strategy" dimensions are performing well, as most of the elements reside in the "keep up the good work" section. This reflects as some of the business' strong points, as it is the best performing dimensions with regards to readiness for artificial intelligence as seen in Figure 85 is organisational governance and leadership and it is seen as a very important dimensions in combination with the security dimension, thus the business must continue current efforts and resource allocation with regards to these dimensional improvements. The security dimension is one of the best performing readiness dimensions, this in combination with its relevant importance, it is deduced that the business should continue their current focus and resource allocation towards the improvement of this dimension. The most highly prioritized readiness elements within these dimensions can be seen in Table 53.

There is a strong grouping of knowledge and information management dimension elements in the “concentrate here” quadrant in section 7.3, thus the organization should shift their attention and resources towards the development and improvement of this dimension. Figure 85 indicates that the readiness score of this dimension is 4.04. It is thus evident that this readiness dimension is underperforming with regards to the long-term aim of improvement. To further narrow the business’ focus, the highest prioritized elements within this dimension is shown in Table 58. This should be the businesses immediate focus and highest priority as this readiness dimension is identified as a very important dimension, but is under performing. All readiness elements within this dimension, require focus and resources to improve the performance. Currently the technology management and Employee and culture dimensions are overall seen as an lower priority dimensions in the short to medium term, due to its grouping elements in the “low priority” section as seen in Figure 81. In terms of business readiness, the technology management and Employee and culture dimension are one of the lowest performing dimensions, with readiness scores of 4.02 and 3.87 respectively. Due to its placement in the IPA overall results, this dimension requires improvement in the long-term.

Looking at the combination of the readiness evaluation and the multiple perspective IPA analysis. The long-term business focus, through the use diagonal line method, across all perspectives still point towards overall improvement of most dimensions, but there are some differences with regards to the different perspectives of the Employee and culture and technology management dimensions. With regards to these two dimensions the strategy perspective categorized the Technology management dimension as a “low priority”, as well as the Employee and culture dimension. The operational perspective shifts the ”low priority” categorization of both dimensions, to “improve here”. The tactical perspectives categorizes the Technology management dimension as “Improve here” and Employee and culture dimension as “Low priority”. The short to medium term aim of the business, using the original mean axis method, is identical for all perspectives. Similar conclusions can be reached for these perspectives in comparison to the overall IPA.

Once again, it is deduced that the business requires definitive effort and resources to improve its readiness for AI implementation. Through the use of the IPA, the readiness dimensions and elements within each dimension has been prioritized for business, to increase their readiness in the short to medium term. These results conclude this chapter. This model has provided the business with the ability to evaluate their readiness for new technologies, such as artificial intelligence, through the inputs from experienced and knowledgeable individuals in the business. This is accompanied by the ability to prioritize dimensions and elements within the business that will generating the most growth in readiness for AI, this is further diversified by tailoring these prioritizing elements and dimensions according to three focuses. These focuses are a strategic, operational and tactical. These outputs satisfy the proposed research objectives. The following conclusion chapter will focus on summarization and interpretation of the study as a whole.

Chapter 8: Conclusion

This chapter begins with a summary of the study followed by discussion of the conclusions drawn from the objectives and processes with which this study engaged. The contributions that this study provides in practice are assessed and the final sections focuses on personal reflections, limitations and recommendations for future research with regards to this study area.

Chapter 8 Objectives	Summarise the study into integral phases/process steps
	Develop conclusions from processes and objectives of the study
	Describe the contributions of this study for business'
	Provide personal reflections with regards to the study
	Describe limitations of the study
	Describe recommendations for future developments

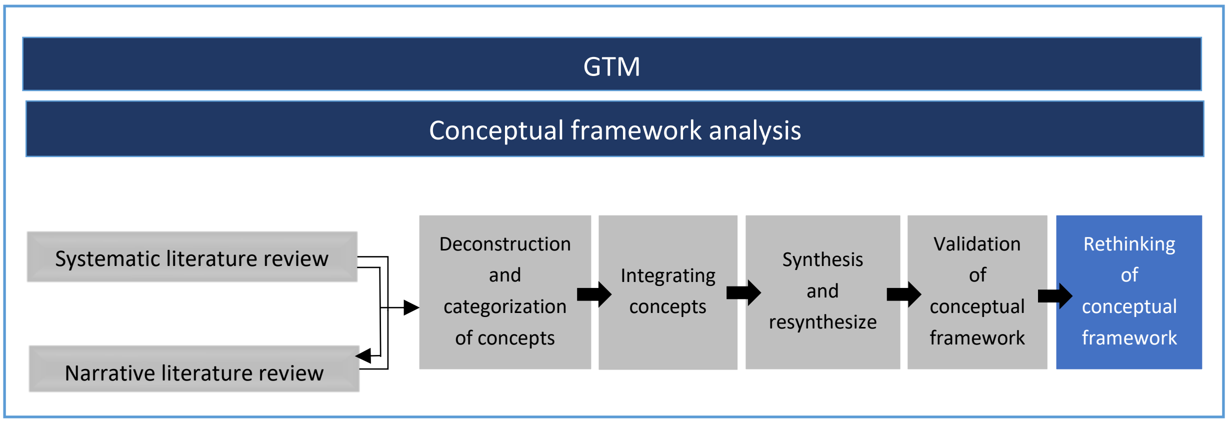

Figure 92. Research methodology process step

8.1 Summary and conclusions of study phases

This section focuses on the development and summarisation of the different study phases in the study. Important points within each research phase are identified and a chapter break down of these salient points can be seen in the table below.

Table 62. Research study summary and salient point identification

Study phase	Summary and identification of salient points
Chapter 1: Introduction	This section shaped the initial focus of the study by providing insights into the back ground of AI in the past and present. From the literature it can be concluded that AI is a large emerging technology that shows a lot of potential and growth to shape the business world. Businesses wishing to capitalise on this opportunity are faced with a range of challenges, one of these being the difficulty to integrate or

	initiate the process of AI implementation, thus this became the main focus of the study. It was also identified that there are general inflated expectations with regards to AI. Thus, the development of the readiness model is aimed to assist in solving the problem/challenge stated, as well as adding to the process of improving individuals' expectations and knowledge on AI.
Chapter 2: Methodology	Chapter 2 focused on developing the appropriate research methodology for this study. After the foundational grounded theory methodology was identified, it was decided to incorporate a more specific methodology, which focuses on the development of the framework or model. After multiple methodologies were evaluated, the conceptual framework analysis was chosen as the most applicable methodology. The integration of these two methods formed the research methodology process steps that would be followed throughout the study. As literature reviews form an integral part of research, the systematic literature review and narrative literature review were discussed and the systematized protocol was developed, to guide the researcher during the literature reviews.
Chapter 3: Narrative literature review	The initial focus of the narrative literature review was to identify academic literature on readiness and maturity models for artificial intelligence implementation in businesses. The initial review found no literature that focused exactly on this adoption barrier for AI. This provided some insights into the value that a readiness or maturity model focused on AI could have for businesses wishing to capitalise on this technology. The initial literature focused on the integration of different AI approaches to form hybrid AI systems and processes, AI methods to assist the implementation of a computerised intelligent autonomous manufacturing environment and a maturity model that assesses the readiness of a business with regards to industry 4.0. The narrative literature review provided a supplementation literature review to the systematized literature reviews. From the identification of concepts in the systematized literature reviews, the focus of the narrative literature review was primarily on the development of maturity models, decision making methods and AI readiness concepts. During the parallel completion of the different views, the lack of academic application of maturity models towards AI and generic AI maturity levels, the study's focus shifted towards readiness and readiness models as these would form the foundational structures that is required to assist businesses in implementing AI.
Chapter 4: Systematized	The initial focus of the systematized literature review was to develop and identify the most important steps of a systematic literature review, to derive a systematized literature review from that. After the protocol had been developed, the next step

literature review	was to conduct a review of certain topics, as identified in the previous sections. At this stage of the study the focus was either maturity or readiness with regards to the implementation of artificial intelligence. The first literature review focused on the maturity aspect. Very few academic papers were found that assist businesses implement AI into their structures through models or frameworks. A small comparative review was conducted with the results of this systematized literature review, to find common themes between academic and business sources. Due to the lack of academic material to serve as a foundation, the study's focus was shifted towards readiness. The main focus was determining a business' readiness for implementing artificial intelligence in its business structures. The second systematized literature review focused on business readiness for artificial intelligence. It was evident from the results that there is also a shortage on academic papers regarding readiness of businesses for artificial intelligence. The literature that was found was synthesized and categorized to provide the foundational requirements that in combination with the narrative literature review formed the readiness model. Through this the readiness dimension and their elements were identified.
Chapter 5: Development of the readiness model components	The objective of this chapter was to further investigate the readiness elements that were identified in the previous chapters and possibly derive variables from these elements. It was found that a few of these elements were very complex and related to large-scale business components, the focus thus was to investigate and synthesise on a high level each of these elements. It is important to identify the exact view/aspect the readiness model is presenting each of these readiness elements. After the completion of this chapter, the readiness model had the core dimension, elements and variables indexed and ready for validation and evaluation.
Chapter 6: Constructing the readiness model	This chapter focused on identifying the operations of the readiness model. This encompasses the pre-requisites and process steps of operating the model. This section also developed the validation process for this study, incorporating the insights from SMEs, as well as business experts. The first validation steps were completed through the interviews with and surveys administered to SMEs. The validation results were very positive, with regards to the readiness dimensions, elements and variables. The results showed that these individuals do not use any structured frameworks or models that specifically target business readiness for artificial intelligence. This further validated the requirement for a model, such as the one developed. The next stage was the development of weighting calculation

	methods. There were two method identified, namely the Likert scale method and the AHP weighting method. The initial aim was to use the Likert scale to determine the readiness dimension weightings for strategy, operations, tactical and overall (integration of the previous three). The AHP method was used to determine the weightings of the readiness elements. The data from two SMEs was collected and calculated using the AHP method. Large inconsistencies within the SMEs results were found. The literature identified some weaknesses with regards to this method, which affected these results. Due to constraints on cooperation and time, the Likert scale method was used to determine the readiness element weightings. From these calculation methods, the weighting index was developed. The final section was focused on developing the calculations and analysis methods, which would be used to analyse the data, as well as satisfy the objectives set out for this study. The two outputs from the readiness model are the business readiness evaluation and the IPA graphical categorization and prioritization of the readiness dimensions and elements. The readiness evaluation provides the evaluations across all the dimensions as well as elements. The IPA provides an interesting perspective, as the IPA has four different focus points with which the business can approach the categorization and prioritization of dimensions and elements. These focus points are overall, strategic, operational and tactical.
Chapter 7: Case study	The first focus of this chapter was to identify what requirements are necessary for a case study for it to be viable within the context of this study. The appropriate case study was identified and all organisational permission requirements met. A brief background was given on the business as well as their current situation with regards to AI. Interviews and surveys were conducted with chosen individuals at different levels and sections within the business to determine the business readiness for artificial intelligence. The IPA section was divided into four outputs: overall IPA, strategic IPA, operational IPA and tactical IPA. All these outputs provide the business with different perspectives on the categorization and prioritization of readiness elements. The overall IPA was used in combination with the readiness evaluation results to provide insights and interpretations on the current situation of the business. The business dimension readiness results are: Employee and culture = 3.87, Technology management = 4.02, Organisational governance and leadership = 5.84, Strategy = 4.57, Infrastructure = 4.4, Knowledge and information management = 4.04 and security = 5. In collaboration with the IPA, these results identified that the governance and leadership is the best performing dimension when taking into account both the readiness level and its

	importance. The dimension that requires the most attention in the short term is the knowledge and information management dimension. This has one of lowest readiness results and has an extremely high importance. The technology management dimension has a low readiness results, but was categorized as a lower priority, it can thus become a medium to long term focus of the business.

8.2 Achieving research objectives

The main objective of this study was to develop a readiness model for businesses to assess their readiness for artificial intelligence. This was combined with the ability to categorize and prioritize these components so as to tailor business readiness. As seen in Chapter 1, section 1.3, the objectives of this study are:

i. Developing and identify literature and understanding of AI readiness in business
ii. Develop systematized literature review.
iii. Developing a readiness model
iv. Validate the readiness model
v. Attain applicable, real-world case study.
vi. Apply validated readiness model to viable and applicable cases study

The table below describes the objectives, evaluations and references with regards to the completion of these objectives.

Table 63. Evaluation of study on achieving objectives

Objective number	Chapter reference	Evaluations
i	Chapter: 1, 3, 4	The research that substantiated the background analysis and initial literature review provided insights into different types of AI being developed, researched and used today. Practical examples of AI being used by corporations, the origin of AI, insights into the future growth and adoption of AI, as well as the challenges associated with it were discussed. The literature review chapters provided the foundation of requirements for developing a readiness model aimed at AI implementation. This literature was used to develop, refine and finalize the core of the readiness model. This understanding encompasses:

		• Uses of AI • Application of AI in the real world • Types of AI methods • Requirements with regards to smaller elements, as well as dimensions • Future growth of AI • Identify a possible gap in literature • Origin of AI • Challenges associated with AI • Similar digitalized technology fundamentals
ii	Chapter 4	The systematized literature review was developed through derivation of a systematic literature review, which formed the key processes: • Determine key research questions and key words • Determine data sources and search terms • Determine application of selection criterion • Develop study quality assessment procedures • Develop the data extraction strategy • Develop analysis strategy The development of the systematized literature review was important to build the foundation of the readiness model. The objective was met through the development and application of two systematized literature reviews. These literature reviews identified: • Different business dimensions that influence readiness • Different perspectives regarding AI • Requirements with regards to smaller elements
iii	Chapter 5, 6	After the readiness dimension, elements and variables had been identified through literature reviews, Chapter 5 further developed the foundational dimensions and elements, as well as deriving variables from the elements. Chapter 6 focused on developing the operations process of the readiness model through the identification of pre-requisite process steps, as well as the

		operational steps. The readiness model components developed in chapter 5, were validated and weighting calculations methods were developed. To complete the pre-requisite process steps for the model, SMEs were interviewed and surveys were administered to develop the weightings for the model. After the completion of chapter 6, the model was developed and ready to be applied to a real-world case study.
iv	Chapter 6.1, 6.2.3, 7.2	The validation process was first developed to provide some guidelines towards validating this study. The first validation with regards to the components was done in chapter 6.2.2, when semi-structured interviews and surveys were administered to SMEs. Overall the SMEs identified that all the readiness elements that were incorporated in the readiness model were seen as relevant to the study. The goal of the study was validated by identifying that although there were no concrete readiness models or frameworks used by the SMEs to determine business readiness for AI, there was a need. After the business individuals were interviewed and had completed the surveys, they confirmed that the developed model and its outputs are valuable towards its intended aim.
v	Chapter 7.1	To achieve this objective the following requirements were set in place to ensure that the case study was a real-world applicable case study. These requirements were: • The business is in the starting phase of AI implementation, research and design for the business. • Individuals in the business have basic, as well as more detailed knowledge with regards to AI from a technical, business and management perspective. • Individuals with the required knowledge are present in different levels and divisions within the business. • The organization and individuals have agreed to partake in the study and the required documentation has been completed. These factors were taken into account, as well as the fact that the business needed to be a functioning and listed company.

vi	Chapter 7	Case study requirements as seen above were met and all the required processes were completed to start the evaluation. This is followed by the semi-structured interviews and administered surveys to attain the business' performance on various variables. This is used to calculate the readiness of the business as well as, to conduct the various types of IPA. This provided the business with the ability to determine their readiness for AI, as well as different perspectives with regards to the categorization and prioritization of their readiness dimensions and elements.

8.3 Contributions and implications of this research

This section focuses on elaborating the contributions and implications this research by completing the following questions:

i. How does this study contribute to the body of knowledge?

This research addresses a identified gap in the literature with regards to business readiness and maturity for AI through the use of models/frameworks. It combines literature studies to focus on AI implementation in business, through narrative and systematized literature reviews. It provided foundational aspects and features to develop the readiness model. The research study provides literature identification, study analysis, concept deconstruction, concept categorization and concept synthesis to define the foundational dimensions and elements to develop the readiness model for AI evaluations. The research presents multiple validation process steps through surveys and semi-structured interviews aimed at model component validation and research aim validation. This indicates the viability, applicability, usefulness and need for a enterprise technology readiness model aimed at artificial intelligence.

ii. For whom is the framework designed and who can utilise the tool?

The readiness model was originally intended for use by all sizes of business. However, as the model developed, the readiness model dimension, elements and variables became more applicable to large companies and corporations. The model is specifically designed for corporations that are at the start of their AI journey or project to assist them in the complex challenge of implementing AI into existing business structures. The model outputs provide businesses with the ability to measure their readiness for AI, as well as providing a range of focus points regarding the prioritization and categorization of the readiness elements and dimensions. All these will assist a business in future resource and strategic planning.

iii. What are the short- and long-term implications of this research?

The short-term implications of this research should impact individuals, managers, stakeholders and corporations considering AI implementation. The outputs of this model provide knowledge, opportunity and strategic guidance through better understanding of the technology, identification of opportunities, prioritization of elements and newly generated perspectives. The research could possibly generate more attention to the area of AI to further improve and continuously adapt to this changing technology. The development, change and evolution of AI is extremely rapid, thus the applicability of this model is unlikely to remain without alteration in the future as trends change. The focus on business readiness for new types AI, however, could be continuously researched and developed to provide businesses with on-going academic support.

8.4 Critical reflection

The developed readiness model was first aimed towards assessing business maturity for AI implementation. Due to lack of foundational academic literature required to construct the model, the focus shifted towards readiness. One of the focuses of the semi-structured interviews and surveys were to obtain the 'performance' of the business with regards to readiness for AI implementation. It is important to note that this performance is based on informed individuals perceived satisfaction. Thus, some variability is expected in the data. It must also be noted that some readiness dimensions have fewer elements than others, which influences the weight distribution of those elements. The Overall IPA graph was initially skewed, because the security dimension had one element and the security dimension was weighted high. Thus, caused it to be an extreme outlier. One explanation is that the incorporation of dimensional weighting accounts for this when the overall readiness evaluations are calculated.

An interesting finding was that, within the employee and culture dimension, the job security element was ranked very low in terms of importance in comparison to the other elements. When dealing with a technology that could potentially replace certain jobs at a company, it is likely that employees would see the technology more as a threat than an asset, thus reducing the overall collaboration and possibly causing delays in the project completion. With these insights, this element could have been expected to have had a relatively high weighting.

8.5 Study limitations

The researcher has reflected critically on the literature review material, processes, development processes, evaluation and validation processes, the completed model and the semi structured interviews and surveys. These are the identified limitations with regards to this study:

i. One academic database was used to conduct systematized literature review, however it is a large academic literature data base and during the study the literature was combined from other databases.
ii. The screenings and application of quality assessments were done by one researcher, with the guidance of the systematized literature review protocol.
iii. Seven SMEs were used to develop the weightings of the model, but the SMEs incorporated a range of different experience, education and focus to enrich this study. For the purposes of developing a model it was sufficient, but future development of the model should incorporate more SMEs.
iv. Due to time and cooperation limitations the AHP method was discarded for determining readiness element weightings and replaced by the Likert scale method. Future use or development of this model should incorporate the AHP method for weighting development
v. The readiness model was developed to be generic and usable for all sizes of business, but through development and iterations, it is more aimed towards large businesses and corporations.
vi. The model is comprised of many different readiness elements, which have only been investigated on a high level, thus future research will require more in-depth analysis of each element and variable
vii. The long-term unaltered applicability of this model is unfavourable, thus continuous research and development will be required.
viii. The management tool did not incorporate a continuous improvement process (iterations) with regards to inputs from multiple case studies. The readiness model is only applied to one large, viable and applicable insurance corporation.
ix. Some readiness dimensions have fewer elements than others, which influences the weight distribution of those elements.

8.6 Recommendations and future work

Appraisal of the model developed and applied in chapters 6 and 7, and considering the limitations mentioned in section 8.5, provides a guideline for recommendations and future work for the model. The first recommendation focuses around the development of the readiness element weightings. The AHP weighting method should be used to derive more accurate data from the SMEs. More systematized literature reviews should be conducted on different databases and use more researchers to conduct screening and data extraction. Further in-depth research on each readiness element and variable needed, as well as continuously update the dimensions and elements with most relevant aspects. More SMEs should be consulted to develop the weightings of the model and apply the model to a range of case studies, with a continuous improvement approach after every case study completion.

The future work related to this model focuses on developing more detailed readiness dimensions and elements that are AI specific. Thus, the model can easily alter depending on the type of AI the business is looking to implement. The next adjustment to future models would be to identify quantitative data gathering methods for every readiness element. In this way, the business 'performance' with regards to readiness can be quantitatively supported and this would provide a more accurate image of the readiness of the business for AI. Because the model largely comprises generic technological readiness elements, with the appropriate research the model could be altered to develop a readiness model aligned to a range of new digital technologies.

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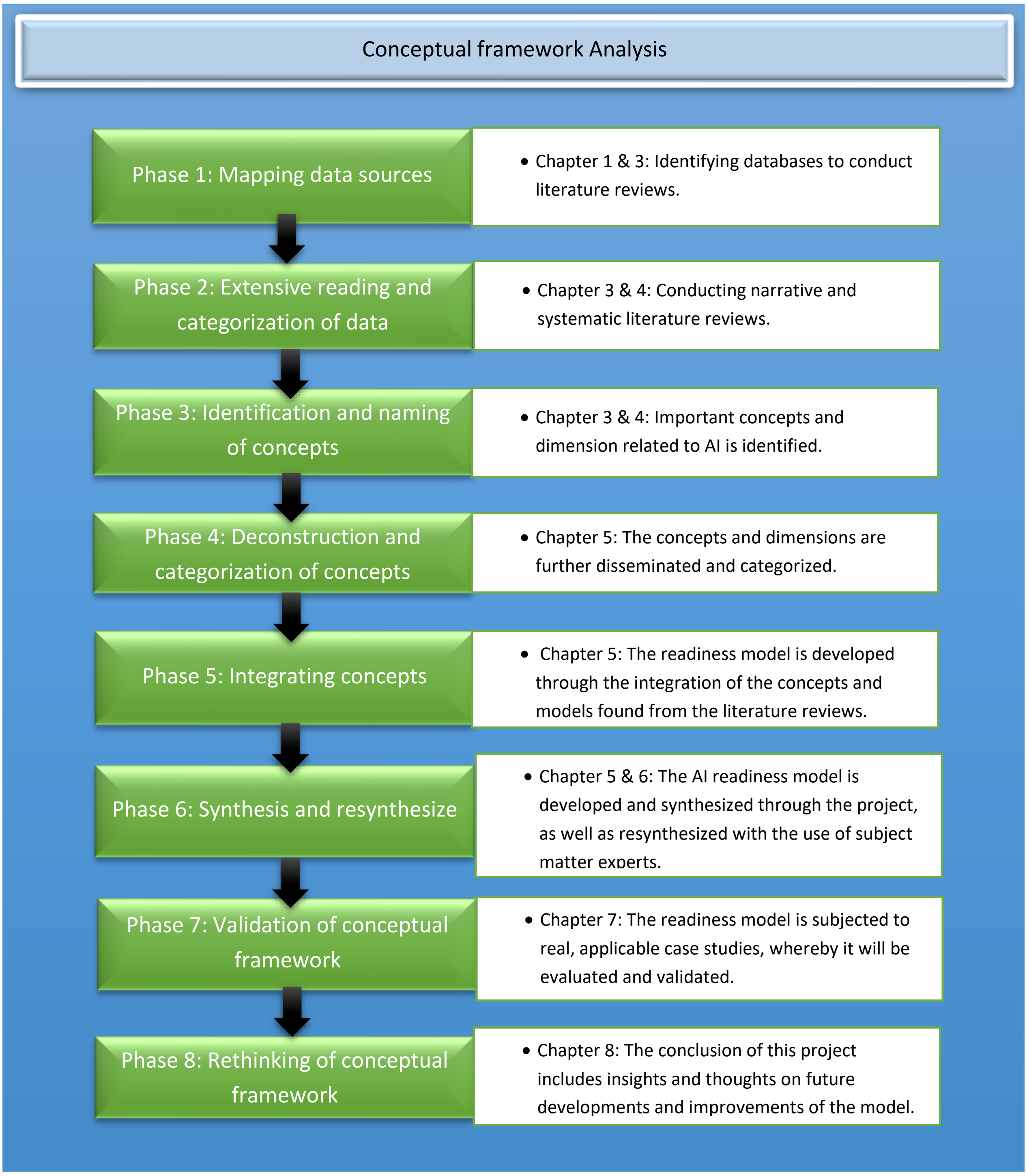
Appendix A

Readiness dimension (d)	Readiness elements (i)	i
Employee and culture	Job Security	**1**
	Perceived usefulness	**2**
	Perceived ease of use	**3**
	Compatibility with existing values and practices	**4**
	Benefits	**5**
	Business Acceptance	**6**
	Skills and expertise	**7**
	Collaboration	**8**
	Certainty	**9**
Technology Management	Technological categorization and planning	**10**
	Technology requirement handling	**11**
	Technological investment and capital management	**12**
	Cost management	**13**
	Technological competitors analysis	**14**
	Cloud resources	**15**
	Network Connectivity	**16**
	Technology Risk Management	**17**
	Quality Management	**18**
	Human resource planning	**19**
Organizational governance and leadership	Executive support	**20**
	Budget	**21**
	Business opportunity	**22**
	Strategic leadership	**23**
	Business cases	**24**
Strategy	Trial-ability	**25**
	Business clarity	**26**
	Observable results	**27**
	Technology roadmaps and scenarios	**28**
	Technology prospect/forecasting	**29**
	Agile delivery	**30**
Infrastructure	Technologic sustainability and position map	**31**
	Communication networks	**32**
	Information networks	**33**

	Services	**34**
	Infrastructure platform	**35**
Knowledge and information management	Management information system and data processing	**36**
	Agent based applications	**37**
	Return on investment	**38**
	Enterprise resource planning in terms of databases and software	**39**
	Technology knowledge management	**40**
	Technology identification and selection	**41**
Security	Cyber security	**42**

Appendix B


Conceptual framework Analysis
Phase 1: Mapping data sources
• Chapter 1 & 3: Identifying databases to conduct literature reviews.
Phase 2: Extensive reading and categorization of data
• Chapter 3 & 4: Conducting narrative and systematic literature reviews.
Phase 3: Identification and naming of concepts
• Chapter 3 & 4: Important concepts and dimension related to AI is identified.
Phase 4: Deconstruction and categorization of concepts
• Chapter 5: The concepts and dimensions are further disseminated and categorized.
Phase 5: Integrating concepts
• Chapter 5: The readiness model is developed through the integration of the concepts and models found from the literature reviews.
Phase 6: Synthesis and resynthesize
• Chapter 5 & 6: The AI readiness model is developed and synthesized through the project, as well as resynthesized with the use of subject matter experts.
Phase 7: Validation of conceptual framework
• Chapter 7: The readiness model is subjected to real, applicable case studies, whereby it will be evaluated and validated.
Phase 8: Rethinking of conceptual framework
• Chapter 8: The conclusion of this project includes insights and thoughts on future developments and improvements of the model.

Appendix C

	Maturity implementation model for artificial intelligence	
1		
2		
3	Authors	Title
4	Alexopoulos C., Diamantopoulou V., Charalabidis Y.	Tracking the evolution of OGD portals: A maturity model
5	de Paiva Guimarães M., Alves B., Martins V.F., dos Santos Baglie L.S., Brega J.R., Dias [	Embedding augmented reality applications into learning management systems
6	Heberle A., Löwe W., Gustafsson A., Vorrei Ö.	Digitalization Canvas – Towards identifying digitalization use cases and projects
7	Prieto A., Prieto B., Ortigosa E.M., Ros E., Pelayo F., Ortega J., Rojas I.	Neural networks: An overview of early research, current frameworks and new challenges
8	Zhao X., Hwang B.-G., Low S.P.	An enterprise risk management knowledge-based decision support system for construction firms
9	Ryan J.C., Cummings M.L.	A Systems Analysis of the Introduction of Unmanned Aircraft Into Aircraft Carrier Operations
10	Ye H.	On the role of the new pattern of communication of intelligent algorithm in modern exhibition marketing
11	Diakou C.M., Kokkinaki A.	Assessment of maturity levels in dealing with low probability high impact events
12	Cannavacciuolo L., Iandoli L., Ponsiglione C., Zollo G.	Knowledge elicitation and mapping in the design of a decision support system for the evaluation of suppliers' competencies
13	Mehdiyev N., Krumeich J., Enke D., Werth D., Loos P.	Determination of Rule Patterns in Complex Event Processing Using Machine Learning Techniques
14	Janom N., Bakar N.H.A., Arshad N.H., Salleh S.S., Aris S.R.S., Mastuki N.	Microsourcing Job Provider Maturity Model
15	Häser F., Felderer M., Breu R.	Test process improvement with documentation driven integration testing
16	Hodicky J.	HLA as an experimental backbone for autonomous system integration into operational field
17	Parra I., Arroyo G., Garcia A.	Experiences and practices in the implementation of IT Governance in Mexican electric utility
18	Oliveira B., Belo O.	Approaching ETL conceptual modelling and validation using BPMN and BPEL
19	Solar M., Meijueiro L., Daniels F.	A guide to implement open data in public agencies
20	El-Gayar O.F., Deokar A.V., Tao J.	DSS-CMM: A capability maturity model for DSS development processes
21	Marulanda C., Marcelo y López P.L.	Collective intelligence model for knowledge management in technology-based clusters
22	Zhou W., Li Y.	Research on quality measuring of CMMI cyclic implementation in software process
23	Srivastava V., Sharfuddin A., Datta S.	Managing quality in outsourcing of high-end services: A conceptual model
24	Solar M., Concha G., Meijueiro L.	A model to assess open government data in public agencies
25	Andrade J., Ares J., García R., Rodríguez S., Suárez S.	Developing a knowledge process quality model evaluation system using commonkads
26	Thorp K.R., White J.W., Porter C.H., Hoogenboom G., Nearing G.S., French A.N.	Methodology to evaluate the performance of simulation models for alternative compiler and operating system configurations
27	De Oliveira J.M.N.	The role of four-hour blocks in promoting active learning strategies: The impressions of students and teachers
28	[No author name available]	32nd International Conference on Information System 2011, ICIS 2011, Volume 3
29	[No author name available]	32nd International Conference on Information System 2011, ICIS 2011, Volume 4
30	[No author name available]	32nd International Conference on Information System 2011, ICIS 2011, Volume 1
31	Beg A., Ahmed F., Campbell P.	Hybrid OCR techniques for cursive script languages - A review and applications
32	Kurze C., Gluchowski P.	Computer-aided warehouse engineering (CAWE): Leveraging MDA and ADM for the development of data warehouses
33	Wang M.-H., Yan Z.-R., Lee C.-S., Hung P.-H., Kuo Y.-L., Wang H.-M., Lin B.-H.	Apply fuzzy ontology to CMMI-based ASAP assessment system
34	Pereira Bila De Carvalho H., Battaglia D., Montini D.Á., Pereira Moreira G.D.S., Dias L./	ETL process model for a manufacture cells production line integration
35	Xu H.	A development process of KMS based on systems engineering methodology
36	Kozma R., Aghazarian H., Huntsberger T., Tunstel E., Freeman W.J.	Computational aspects of cognition and consciousness in intelligent devices
37	Belbaly N., Benbya H.	A stage model for NPD process maturity and IKMS implementation
38	Köster M., Grauel A., Convey H.	Optimisation by clonal selection principles

Maturity implementation model for artificial intelligence

		DATA
Title	Year	Source title
Tracking the evolution of OGD portals: A maturity model	2017	Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)
Embedding augmented reality applications into learning management systems	2017	Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)
Digitalization Canvas – Towards identifying digitalization use cases and projects	2017	Journal of Universal Computer Science
Neural networks: An overview of early research, current frameworks and new challenges	2016	Neurocomputing
An enterprise risk management knowledge-based decision support system for construction firms	2016	Engineering, Construction and Architectural Management
A Systems Analysis of the Introduction of Unmanned Aircraft Into Aircraft Carrier Operations	2016	IEEE Transactions on Human-Machine Systems
On the role of the new pattern of communication of intelligent algorithm in modern exhibition marketing	2015	International Journal of Simulation: Systems, Science and Technology
Assessment of maturity levels in dealing with low probability high impact events	2015	Proceedings of the European Conference on IS Management and Evaluation, ECIME
Knowledge elicitation and mapping in the design of a decision support system for the evaluation of suppliers' competencies	2015	VINE
Determination of Rule Patterns in Complex Event Processing Using Machine Learning Techniques	2015	Procedia Computer Science
Microsourcing Job Provider Maturity Model	2014	Proceedings - 2014 4th International Conference on Artificial Intelligence with Applications in Engineering and Technology, ICAIET 2014
Test process improvement with documentation driven integration testing	2014	Proceedings - 2014 9th International Conference on the Quality of Information and Communications Technology, QUATIC 2014
HLA as an experimental backbone for autonomous system integration into operational field	2014	Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)
Experiences and practices in the implementation of IT Governance in Mexican electric utility	2014	CIGRE Session 45 - 45th International Conference on Large High Voltage Electric Systems 2014
Approaching ETL conceptual modelling and validation using BPMN and BPEL	2013	DATA 2013 - Proceedings of the 2nd International Conference on Data Technologies and Applications
A guide to implement open data in public agencies	2013	Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)
DSS-CMM: A capability maturity model for DSS development processes	2013	Engineering Effective Decision Support Technologies: New Models and Applications
Collective intelligence model for knowledge management in technology-based clusters	2012	Proceedings of the European Conference on Knowledge Management, ECKM
Research on quality measuring of CMMI cyclic implementation in software process	2012	Journal of Software
Managing quality in outsourcing of high-end services: A conceptual model	2012	Total Quality Management and Business Excellence
A model to assess open government data in public agencies	2012	Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)
Developing a knowledge process quality model evaluation system using commonkads	2012	ICAART 2012 - Proceedings of the 4th International Conference on Agents and Artificial Intelligence
Methodology to evaluate the performance of simulation models for alternative compiler and operating system configurations	2012	Computers and Electronics in Agriculture
The role of four-hour blocks in promoting active learning strategies: The impressions of students and teachers	2012	Proceedings of the 40th SEFI Annual Conference 2012 - Engineering Education 2020: Meet the Future
32nd International Conference on Information System 2011, ICIS 2011, Volume 3	2011	International Conference on Information Systems 2011, ICIS 2011
32nd International Conference on Information System 2011, ICIS 2011, Volume 4	2011	International Conference on Information Systems 2011, ICIS 2011
32nd International Conference on Information System 2011, ICIS 2011, Volume 1	2011	International Conference on Information Systems 2011, ICIS 2011
Hybrid OCR techniques for cursive script languages - A review and applications	2010	Proceedings - 2nd International Conference on Computational Intelligence, Communication Systems and Networks, CICSyN 2010
Computer-aided warehouse engineering (CAWE): Leveraging MDA and ADM for the development of data warehouses	2010	16th Americas Conference on Information Systems 2010, AMCIS 2010
Apply fuzzy ontology to CMMI-based ASAP assessment system	2010	2010 IEEE World Congress on Computational Intelligence, WCCI 2010
ETL process model for a manufacture cells production line integration	2010	ITNG2010 - 7th International Conference on Information Technology: New Generations
A development process of KMS based on systems engineering methodology	2009	Proceedings - 2009 International Conference on Computational Intelligence and Software Engineering, CiSE 2009
Computational aspects of cognition and consciousness in intelligent devices	2007	IEEE Computational Intelligence Magazine
A stage model for NPD process maturity and IKMS implementation	2006	Artificial Intelligence and Integrated Intelligent Information Systems: Emerging Technologies and Applications
Optimisation by clonal selection principles	2003	Recent Advances in Intelligent Systems and Signal Processing

Appendix D

Table . Percentage absolute difference from the mean

n	Variable description	Respondent 1 difference	Respondent 2 difference	Respondent 3 difference	Respondent 4 difference	Respondent 5 difference	Respondent 6 difference	Respondent 7 difference	Respondent 8 difference	Respondent 9 difference
1	Employees' perception on job security with regards to AI	40.00%	20.00%	30.00%	10.00%	10.00%	10.00%	10.00%	0.00%	10.00%
2	Employees' perception on the usefulness of AI	28.89%	1.11%	8.89%	1.11%	1.11%	11.11%	21.11%	8.89%	11.11%
3	Employees' perception with regards to ease of use of AI	26.67%	3.33%	33.33%	33.33%	6.67%	6.67%	26.67%	26.67%	23.33%
4	Compatibility of AI with business values and practices	35.56%	24.44%	5.56%	5.56%	14.44%	5.56%	34.44%	4.44%	25.56%
5	Employees' perception on the benefits regarding AI	8.89%	48.89%	21.11%	1.11%	11.11%	8.89%	1.11%	1.11%	31.11%
6	Perceived business acceptance of AI	12.22%	2.22%	7.78%	17.78%	7.78%	22.22%	32.22%	2.22%	37.78%
7	Perceived current skills and expertise capability to implement and manage AI	24.44%	24.44%	5.56%	4.44%	4.44%	15.56%	5.56%	15.56%	15.56%
8	Willingness of employee collaboration with regards to AI	5.56%	15.56%	24.44%	4.44%	25.56%	5.56%	15.56%	14.44%	24.44%
9	Employees' perceived trust/certainty in AI	7.78%	22.22%	17.78%	7.78%	7.78%	2.22%	22.22%	17.78%	12.22%

10	Technological categorization and planning progress for AI			28.57%	11.43%	21.43%	1.43%	11.43%	1.43%	18.57%
11	Identification of technology requirement management structures		25.00%	5.00%	25.00%	25.00%	5.00%	5.00%	5.00%	25.00%
12	Allocation of Investment and capital management for AI	13.33%	26.67%	3.33%	3.33%	33.33%	16.67%	23.33%	13.33%	46.67%
13	Identification of cost management structures for AI	38.89%	31.11%	11.11%	21.11%	28.89%	11.11%	18.89%	28.89%	41.11%
14	Technological competitors analysis for AI		50.00%	10.00%	20.00%	20.00%	20.00%	0.00%	30.00%	40.00%
15	Identification and selection of cloud computing models, such as infrastructure as a service, Platform as a service or software as a service		0.00%	20.00%	10.00%	40.00%	10.00%	10.00%	0.00%	10.00%
16	Identification and satisfaction of requirements regarding Cloud computing models		20.00%	30.00%	30.00%	30.00%	20.00%	10.00%	10.00%	10.00%
17	Identification and selection of cloud computing deployment models, such as		25.00%	25.00%	15.00%	35.00%	25.00%	25.00%	5.00%	5.00%

	cloud, hybrid and on-premises models									
18	Identification and satisfaction of requirements regarding cloud computing deployment models		15.00%	15.00%	25.00%	25.00%	35.00%	5.00%	5.00%	15.00%
19	Identification of required network connectivity within business for AI		8.75%	18.75%	21.25%	21.25%	1.25%	11.25%	8.75%	18.75%
20	Assign responsibilities and roles for managing risks involving AI	22.22%	17.78%	27.78%	7.78%	22.22%	2.22%	12.22%	2.22%	7.78%
21	Prioritization and identification of information system assets	7.78%	17.78%	42.22%	37.78%	17.78%	12.22%	2.22%	2.22%	22.22%
22	Implementation of practices and controls to mitigate risks	38.89%	8.89%	31.11%	11.11%	1.11%	11.11%	11.11%	8.89%	8.89%
23	The identification and assessment of the likehood, as well as the impact of current and emerging threats, vulnerabilities and risks	28.89%	1.11%	11.11%	8.89%	8.89%	31.11%	11.11%	8.89%	1.11%

24	Implementation of periodic improvement/update and monitoring of risk assessment to include changes in systems, as well as operating/environmental conditions that could affect the risk analysis	40.00%	10.00%	0.00%	10.00%	10.00%	20.00%	0.00%	0.00%	10.00%
25	Identification and selection of quality management structures for AI	8.89%	18.89%	41.11%	1.11%	8.89%	21.11%	8.89%	8.89%	8.89%
26	Documentation of data regarding the short to long term goals of the AI project	25.56%	15.56%	34.44%	24.44%	25.56%	4.44%	4.44%	14.44%	15.56%
27	Effort regarding the identification of the types of resources, people and competencies that will be required	15.56%	24.44%	24.44%	24.44%	25.56%	14.44%	15.56%	5.56%	25.56%
28	Executive support regarding AI	15.56%	25.56%	4.44%	5.56%	34.44%	14.44%	14.44%	4.44%	25.56%
29	Allocation of a budget for AI	14.44%	5.56%	5.56%	4.44%	34.44%	25.56%	34.44%	4.44%	55.56%
30	Identification of applicable business opportunities for AI	21.11%	18.89%	1.11%	1.11%	11.11%	8.89%	11.11%	21.11%	38.89%

31	Identification of strategic leadership, which comply with the activities and characteristics of a strategic leader	40.00%	20.00%	10.00%	20.00%	40.00%	20.00%	20.00%	10.00%	40.00%
32	Identification of business cases for AI	25.56%	5.56%	24.44%	5.56%	5.56%	4.44%	15.56%	15.56%	44.44%
33	Capability to conduct a certain amount of testing (test data)	20.00%	10.00%	40.00%	40.00%	40.00%	0.00%	20.00%	20.00%	50.00%
34	Perceived business clarity with regards to AI	7.78%	17.78%	22.22%	17.78%	17.78%	22.22%	7.78%	2.22%	22.22%
35	Identification of methods and criteria involved with generating observable results during testing/implementation of AI		36.25%	23.75%	13.75%	26.25%	13.75%	16.25%	16.25%	43.75%
36	Identification of technology roadmaps and scenarios regarding AI			7.14%	7.14%	22.86%	17.14%	22.86%	2.86%	17.14%
37	Identification of technology forecasting methods for AI			18.57%	21.43%	21.43%	18.57%	1.43%	11.43%	18.57%
38	Development of the agile strategy with regards to AI	11.11%	18.89%	1.11%	1.11%	28.89%	11.11%	8.89%	18.89%	51.11%

39	Development of the technology sustainability and position map for AI			21.43%	38.57%	28.57%	21.43%	18.57%	8.57%	51.43%
40	Identification of communication networks involved with operation of AI			21.43%	28.57%	38.57%	1.43%	8.57%	1.43%	51.43%
41	Identification of information networks involved with implementation, operation and management of AI			24.29%	35.71%	35.71%	4.29%	5.71%	5.71%	54.29%
42	Identification and mapping of services that will incorporate AI		15.00%	15.00%	15.00%	35.00%	5.00%	5.00%	5.00%	55.00%
43	Identification of required infrastructure in terms of cloud resources, as well required additional infrastructure sections			11.43%	38.57%	28.57%	21.43%	8.57%	8.57%	51.43%
44	Initiation of the development of management structures for information systems and data processing	14.44%	24.44%	25.56%	24.44%	14.44%	25.56%	4.44%	4.44%	35.56%

45	Conducting agent based simulations or modelling to indicate possible impacts of AI on business processes		25.00%	35.00%	25.00%	15.00%	25.00%	15.00%	15.00%	35.00%
46	Calculations of the return on investment for AI	3.33%	36.67%	13.33%	3.33%	6.67%	23.33%	26.67%	26.67%	53.33%
47	Initiation of enterprise resource planning (databases and software) for AI	23.75%		26.25%	13.75%	23.75%	36.25%	13.75%	3.75%	16.25%
48	Initiation of technology knowledge management strategies for AI	28.75%		11.25%	28.75%	18.75%	41.25%	1.25%	1.25%	21.25%
49	Analysis of technology compatibility, system impact of AI and the maturity of the AI	30.00%	20.00%	20.00%	30.00%	20.00%	30.00%	10.00%	0.00%	20.00%
50	Identification and development of management of cyber security with regards to Artificial intelligence			10.00%	40.00%	10.00%	30.00%	20.00%	20.00%	10.00%
	Average % difference of evaluations across all variables	21.43%	18.94%	18.53%	17.06%	20.93%	15.42%	13.29%	9.54%	27.67%

Appendix E

Readiness elements (i)	i	Wi(overall)	Relative Wi	Scaled Importance	Pd,i
Job Security	**1**	0.009651495	0.068064058	0.680640581	3
Perceived usefulness	**2**	0.012303775	0.086768404	0.867684044	5.111111111
Perceived ease of use	**3**	0.012877496	0.090814392	0.908143919	4.666666667
Compatibility with existing values and practices	**4**	0.013528377	0.095404518	0.954045179	4.444444444
Benefits	**5**	0.014928599	0.105279131	1.052791309	5.888888889
Business Acceptance	**6**	0.012646966	0.089188653	0.891886527	6.222222222
Skills and expertise	**7**	0.014483633	0.102141154	1.021411538	3.444444444
Collaboration	**8**	0.014637478	0.103226093	1.032260927	4.555555556

Certainty	**9**	0.008245593	0.058149386	0.581493858	3.222222222
Technological categorization and planning	**10**	0.01150287	0.081120286	0.811202855	4.142857143
Technology requirement handling	**11**	0.014675437	0.103493785	1.034937854	4.5
Technological investment and capital management	**12**	0.015137079	0.10674937	1.067493695	4.333333333
Cost management	**13**	0.013213112	0.09318121	0.931812099	4.888888889
Technological competitors analysis	**14**	0.008770539	0.061851397	0.618513974	5
Cloud resources	**15**	0.01281734	0.090390156	0.903901562	4.25

Network Connectivity	**16**	0.015433927	0.108842798	1.088427981	5.125
Technology Risk Management	**17**	0.013542895	0.095506904	0.955069036	4.25
Quality Management	**18**	0.012466148	0.08791349	0.879134901	2.888888889
Human resource planning	**19**	0.013557755	0.095611699	0.956116995	4.055555556
Executive support	**20**	0.031185937	0.219928769	2.199287695	7.444444444
Budget	**21**	0.031140948	0.219611494	2.196114943	4.444444444
Business opportunity	**22**	0.026990412	0.190341181	1.903411811	6.111111111
Strategic leadership	**23**	0.029060502	0.204939826	2.049398259	6
Business cases	**24**	0.021155263	0.149190675	1.491906753	5.555555556

Trial-ability	**25**	0.024207538	0.170715859	1.707158593	5
Business clarity	**26**	0.022035144	0.155395749	1.553957486	3.777777778
Observable results	**27**	0.027186674	0.191725257	1.917252574	4.625
Technology roadmaps and scenarios	**28**	0.022493113	0.158625428	1.586254283	5.285714286
Technology prospect/forecasting	**29**	0.022931537	0.161717274	1.61717274	4.142857143
Agile delivery	**30**	0.024527176	0.17297	1.729700003	4.888888889
Technologic sustainability and position map	**31**	0.02445925	0.172490978	1.724909783	4.857142857
Communication networks	**32**	0.023534474	0.165969295	1.659692948	4.857142857
Information networks	**33**	0.02403394	0.169491614	1.694916139	4.571428571
Services	**34**	0.024221912	0.170817226	1.708172259	4.5
Infrastructure platform	**35**	0.027825869	0.196232971	1.962329711	4.857142857

Management information system and data processing	**36**	0.026744146	0.188604467	1.886044669	3.444444444
Agent based applications	**37**	0.020080791	0.141613305	1.416133049	3.5
Return on investment	**38**	0.023286459	0.164220248	1.642202482	4.666666667
Enterprise resource planning in terms of databases and software	**39**	0.025766316	0.181708638	1.817086382	4.375
Technology knowledge management	**40**	0.023891302	0.168485709	1.684857092	3.875
Technology identification and selection	**41**	0.022076773	0.155689326	1.556893262	4
Cyber security	**42**	0.141800171	1	10	5

Appendix F

Readiness elements (i)	i	Wi(strat)	Wi(op)	Wi(tact)	Scaled Importance (strat)	Scaled Importance (op)	Scaled Importance (Tact)	Wi(overall)	Relative Wi	Scaled Importance	Pd,i
Job Security	1	0.025524632	0.02545	0.020565496	2.985274858	3.844593309	2.970547885	0.009651495	0.309482285	3.094822848	3
Perceived usefulness	2	0.03253893	0.03244	0.026216998	3.805643441	4.901106934	3.786869421	0.012303775	0.394529577	3.945295771	5.111
Perceived ease of use	3	0.034056211	0.03395	0.02743949	3.983099575	5.129644238	3.963450128	0.012877496	0.412926386	4.129263856	4.667
Compatibility with existing values and practices	4	0.03577755	0.03567	0.028826392	4.18442151	5.38891717	4.1637789	0.013528377	0.433797352	4.337973524	4.444
Benefits	5	0.039480618	0.03936	0.031809998	4.617519898	5.946683956	4.594740725	0.014928599	0.478696494	4.78696494	5.889
Business Acceptance	6	0.033446544	0.03335	0.026948274	3.911795006	5.03781448	3.892497319	0.012646966	0.405534269	4.055342686	6.222
Skills and expertise	7	0.038303848	0.03819	0.030861861	4.479888903	5.769435552	4.457788691	0.014483633	0.464428342	4.644283422	3.444
Collaboration	8	0.03871071	0.03859	0.031189674	4.527474087	5.830718245	4.505139128	0.014637478	0.46936148	4.693614798	4.556
Certainty	9	0.021806541	0.02174	0.017569786	2.550419479	3.284563777	2.537837736	0.008245593	0.264400997	2.644009966	3.222
Technological categorization and planning	10	0.03029623	0.02545	0.025410389	3.543344807	3.844717065	3.670360092	0.01150287	0.368847994	3.688479945	4.143

Technology requirement handling	11	0.038652126	0.03247	0.032418738	4.520622243	4.905114921	4.682669166	0.014675437	0.470578659	4.705786591	4.5
Technological investment and capital management	12	0.039867998	0.03349	0.033438528	4.662826588	5.059414177	4.829970989	0.015137079	0.485381561	4.853815615	4.333
Cost management	13	0.034800658	0.02923	0.029188393	4.070167578	4.416347715	4.216067433	0.013213112	0.423688134	4.236881336	4.889
Technological competitors analysis	14	0.023099822	0.0194	0.019374538	2.701677222	2.93146309	2.79852196	0.008770539	0.281233772	2.812337718	5
Cloud resources	15	0.033758275	0.02836	0.028314114	3.948253984	4.284064999	4.089783706	0.01281734	0.410997417	4.109974171	4.25
Network Connectivity	16	0.040649837	0.03414	0.034094281	4.754267822	5.158632767	4.92469004	0.015433927	0.494900228	4.949002275	5.125
Technology Risk Management	17	0.035669242	0.02996	0.029916901	4.171754187	4.526574575	4.321295532	0.013542895	0.434262893	4.342628926	4.25
Quality Management	18	0.032833307	0.02758	0.027538315	3.84007288	4.166682764	3.977724726	0.012466148	0.399736198	3.997361978	2.889
Human resource planning	19	0.03570838	0.02999	0.029949727	4.176331684	4.531541402	4.326037114	0.013557755	0.434739392	4.347393917	4.056
Executive support	20	0.085501782	0.06619	0.068610503	10	10	9.910326772	0.031185937	1	10	7.444
Budget	21	0.085378435	0.06609	0.068511524	9.98557373	9.98557373	9.896029867	0.031140948	0.998557373	9.98557373	4.444

Business opportunity	22	0.073999005	0.05728	0.059380154	8.654674035	8.654674035	8.577064779	0.026990412	0.865467404	8.654674035	6.111
Strategic leadership	23	0.079674525	0.06168	0.063934449	9.318463717	9.318463717	9.234902044	0.029060502	0.931846372	9.318463717	6
Business cases	24	0.058000909	0.0449	0.046542557	6.783590691	6.783590691	6.722760043	0.021155263	0.678359069	6.783590691	5.556
Trial-ability	25	0.067864844	0.04924	0.049367799	7.937243198	7.439349446	7.130847283	0.024207538	0.776232504	7.762325036	5
Business clarity	26	0.061774625	0.04482	0.044937513	7.224951761	6.771739197	6.490922144	0.022035144	0.706573083	7.065730826	3.778
Observable results	27	0.076216731	0.0553	0.05544332	8.914051692	8.354883914	8.00841548	0.027186674	0.871760697	8.71760697	4.625
Technology roadmaps and scenarios	28	0.063058523	0.04575	0.045871475	7.37511211	6.912480167	6.625826731	0.022493113	0.721258199	7.212581994	5.286
Technology prospect/forecasting	29	0.064287627	0.04665	0.046765578	7.518864025	7.047214697	6.754973959	0.022931537	0.735316596	7.353165956	4.143
Agile delivery	30	0.068760935	0.04989	0.050019654	8.042046962	7.537578995	7.225003354	0.024527176	0.786481917	7.864819171	4.889
Technologic sustainability and position map	31	0.06721318	0.05537	0.060855108	7.861026825	8.365975668	8.790111944	0.02445925	0.78430384	7.843038396	4.857
Communication networks	32	0.064671928	0.05328	0.058554247	7.563810533	8.049667847	8.457768023	0.023534474	0.754650223	7.546502225	4.857
Information networks	33	0.066044442	0.05441	0.059796927	7.72433513	8.220503656	8.637264825	0.02403394	0.770665949	7.706659493	4.571

Services	34	0.066560983	0.05484	0.060264605	7.784747977	8.28479709	8.704817793	0.024221912	0.77669341	7.766934098	4.5
Infrastructure platform	35	0.076464533	0.063	0.069231323	8.943033803	9.517484785	10	0.027825869	0.892256941	8.922569412	4.857
Management information system and data processing	36	0.070826844	0.06057	0.060017438	8.283668776	9.150962716	8.66911609	0.026744146	0.857570691	8.575706912	3.444
Agent based applications	37	0.053180201	0.04548	0.045063979	6.219776933	6.870982937	6.509189315	0.020080791	0.643905321	6.439053211	3.5
Return on investment	38	0.061669812	0.05274	0.052257927	7.21269313	7.967856719	7.548306886	0.023286459	0.746697436	7.466974356	4.667
Enterprise resource planning in terms of databases and software	39	0.068237246	0.05836	0.057823057	7.980798113	8.81638172	8.352152554	0.025766316	0.826215864	8.262158638	4.375
Technology knowledge management	40	0.063271625	0.05411	0.053615276	7.400035809	8.174814036	7.744366805	0.023891302	0.766092174	7.660921742	3.875
Technology identification and selection	41	0.058466185	0.05	0.04954323	6.838007772	7.553942084	7.156187048	0.022076773	0.707907958	7.079079584	4
Cyber security	42										5

Appendix G

Readiness elements (i)	i	Wd,i	Rd,i	Wd,i*Rd,i
Job Security	**1**	0.071537339	3	0.214612016
Perceived usefulness	**2**	0.09119616	5.111111111	0.466113707
Perceived ease of use	**3**	0.095448613	4.666666667	0.445426859
Compatibility with existing values and practices	**4**	0.100272971	4.444444444	0.445657649
Benefits	**5**	0.110651481	5.888888889	0.651614279
Business Acceptance	**6**	0.093739913	6.222222222	0.583270568
Skills and expertise	**7**	0.107353375	3.444444444	0.369772735
Collaboration	**8**	0.108493677	4.555555556	0.494248975
Certainty	**9**	0.061116725	3.222222222	0.196931669
Technological categorization and planning	**10**	0.081154648	4.142857143	0.336212113
Technology requirement handling	**11**	0.103537625	4.5	0.465919313
Technological investment and capital management	**12**	0.106794588	4.333333333	0.46277655
Cost management	**13**	0.093220681	4.888888889	0.455745553
Technological competitors analysis	**14**	0.061877597	5	0.309387987
Cloud resources	**15**	0.090428445	4.25	0.384320892

Network Connectivity	**16**	0.108888904	5.125	0.558055631
Technology Risk Management	**17**	0.09554736	4.25	0.406076281
Quality Management	**18**	0.08795073	2.888888889	0.254079887
Human resource planning	**19**	0.0956522	4.055555556	0.387922813
Executive support	**20**	0.220301889	7.444444444	1.640025175
Budget	**21**	0.219984076	4.444444444	0.977707003
Business opportunity	**22**	0.190664104	6.111111111	1.165169524
Strategic leadership	**23**	0.205287516	6	1.231725096
Business cases	**24**	0.149443784	5.555555556	0.830243247
Trial-ability	**25**	0.166473402	5	0.832367011
Business clarity	**26**	0.151534011	3.777777778	0.57246182
Observable results	**27**	0.186960696	4.625	0.864693219
Technology roadmaps and scenarios	**28**	0.15468343	5.285714286	0.817612417
Technology prospect/forecasting	**29**	0.157698441	4.142857143	0.653322111
Agile delivery	**30**	0.168671525	4.888888889	0.824616346
Technologic sustainability and position map	**31**	0.18344235	4.857142857	0.891005698
Communication networks	**32**	0.176506607	4.857142857	0.857317808
Information networks	**33**	0.180252557	4.571428571	0.824011689

Services	**34**	0.181662331	4.5	0.817480491
Infrastructure platform	**35**	0.20869171	4.857142857	1.01364545
Management information system and data processing	**36**	0.191414141	3.444444444	0.659315376
Agent based applications	**37**	0.143722944	3.5	0.503030303
Return on investment	**38**	0.166666667	4.666666667	0.777777778
Enterprise resource planning in terms of databases and software	**39**	0.184415584	4.375	0.806818182
Technology knowledge management	**40**	0.170995671	3.875	0.662608225
Technology identification and selection	**41**	0.158008658	4	0.632034632
Cyber security	**42**	1	5	5

Appendix H

Survey Protocol

*Note: This survey will be done via an online platform and this document only indicates the format and nature of some questions that will be asked. It is also subject to minor changes. Elaboration of each element is not provided due to it being administered to subject matter experts.

Dear participant

Thank you for your participation as part of the research involved in completing my Master's degree in Engineering Management. The title of the study is," Development of an AI readiness model to assist in the implementation of artificial intelligence in business".

The aim of the survey is to provide the interviewer with some practical insights on the importance/weighting of the readiness models' dimensions and elements. This model was developed to assist in the implementation of artificial intelligence into the business. The survey is administered to different SMEs (subject matter experts that specialize on different dimensions in business and technology) and management. This aims to create a more balanced and complete result.

The signed institutional permission form for conducting interviews is attached. The participation in this study is completely voluntarily and the participant is free to withdraw from the study without any negative consequences. If the participant wishes to withdraw from the study, the data gathered from the specific participant through the interview/survey will be permanently deleted/destroyed. The participants are also free to refuse to answer questions they do not feel comfortable with. Data generated/obtained from this survey is anonymous. Any personal information disclosed within the survey answers will be used anonymously.

Principal investigator: M. Nortje (MEng Engineering Management candidate) – 18485189@sun.ac.za

Supervisor: Prof S. Grobbelaar – ssgrobbelaar@sun.ac.za

The purpose of this survey is better understand the readiness dimensions and their elements. Specifically their weightings/importance to subject matter experts and managers involved with implementing/integrating artificial intelligence into business. The survey covers eight large business readiness dimensions/themes, each with a set of elements/components. The readiness model was developed through a combination of models namely, technology readiness model, technology organization environment framework, diffusion of innovation, technology acceptance model, employee readiness and more literature. This artificial intelligence readiness model is generic in nature, thus applicable to and for a range of case studies and subject matter experts.

Section 1:

This section encompasses collection of data on the interviewee. This provides a better understanding of the subject matter experts' field of expertise and knowledge. The question are:

1.1 What is your profession ?

1.2 What is your area of expertise in terms of AI/robotics or technology integration ?

1.3 Within your field, with regards to AI technology, how do you measure your business' readiness or maturity with regards to AI integration and implementation ?

Section 2:

This section focuses on validating the artificial intelligence readiness model elements used in the model. Could you please state whether the elements are relevant or irrelevant in terms of determining a business' readiness for introducing new technologies, such as artificial intelligence. The last column is provided to identify which dimension the element should move to, if the element is not in the appropriate category.

Readiness dimension and element		Relevant	Irrelevant	Dimension change
Technology management	Human resource planning			
	Quality Management			
	Technology Risk Management			
	Network Connectivity			
	Cloud resources			
	Technological competitors analysis			
	Cost management			
	Technological investment and capital management			
	Technology requirement handling			
	Technological categorization and planning			
Employee and culture	Job Security			
	Perceived usefulness			
	Perceived ease of use			
	Compatibility with existing values and practices			
	Benefits			
	Business Acceptance			
	Skills and expertise			

	Collaboration			
	Certainty			
Organizational governance and leadership dimension	Executive support			
	Budget			
	Business opportunity			
	Strategic leadership			
	Business cases			
Strategy	Trial-ability			
	Business clarity			
	Observable results			
	Technology roadmaps and scenarios			
	Technology prospect/forecasting			
	Agile delivery			
Infrastructure	Technologic sustainability and position map			
	Communication networks			
	Information networks			
	Services			
	Infrastructure platform			
Knowledge and information management	Management information system and data processing			
	Agent based applications			
	Return on investment			
	Enterprise resource planning in terms of databases and software			
	Technology knowledge management			
	Technology identification and selection			

Section 3:

These questions are aimed to identify the weighting/importance of each dimension in relation to strategy, operations and tactics. This section incorporates the TRM (technology readiness model) evaluation method.

It is important to note that the importance of the technology elements should be evaluated with the focus on the implementation of artificial intelligence into the business.

Identify the weighting/importance of each dimension with respect to strategy, operations and tactics. Please mark the importance on a scale of 1 to 5. 1 (not important at all) - 5 (very important). Mark an “x” in the cell you wish to answer. An example is given to assist in answering the survey.

Example:

Readiness dimension	**Strategy**					**Operational**					**Tactical**				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Employee and culture			X						X					X	

Survey:

Readiness dimension	**Strategy**					**Operational**					**Tactical**				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Employee and culture															
Technology Management															
Organizational governance and leadership															
Strategy															
Infrastructure															
Knowledge and information management															
Security															
Environmental context															

Section 4:

This section involves the elements of the readiness dimensions. It is important to note that the importance of the technology elements should be evaluated with the focus on the implementation of artificial intelligence into the business.

The pairwise comparisons form an n x n matrix (P). The entries are denoted P_{ij}, The entries encompass the importance of i^{th} element with respect to the j^{th} element. When P_{ij} > 1, the i^{th} element/criterion has a higher importance than the j^{th} element/criterion. The opposite holds true when P_{ij} < 1. When P_{ij} = 1, then the elements are equally important. Once the whole number is given to the appropriate position, the reciprocal is entered in the transpose position. It is important to note that:

$$P_{ij} \bullet P_{ji} = 1$$

The scale of importance or absolute numbers can be seen in the table below. The table shows the number, definition and explanation of each intensity of importance.

Table The scale of absolute numbers.

Intensity of importance (P_{ij})	Definition	Explanation
1	Equal importance	The two criterion/elements are equally important.
2	Slight importance	Through experience and judgement, one criterion is viewed as slightly more important.
3	Moderate importance	
4	Moderate plus importance	Through experience and judgement, one criterion is viewed as largely more important.
5	Strong importance	
6	Strong plus importance	The element is very strongly favoured over the other through demonstration in practice.
7	Very strong importance	
8	Very strong plus importance	The element/criterion most favoured over the other criterion.
9	Extreme importance	

Please evaluate the readiness elements within each readiness dimension. This will be used to develop the pair wise comparisons used in the AHP method. The reciprocal values will be added during the analysis of the survey. Due to the nature of these tables, when the i^{th} element is less important then the j^{th} element, a fractional value can be added. These fractional values represent the opposites of the table above. Thus the values can be entered as: 1/n, where n ∈ [1,2 ... ... 9].

		j^{th}									
		Technological categorization and planning	Technology requirement handling	Technological investment and capital management	Cost management	Technological competitors analysis	Cloud resources	Network Connectivity	Technology Risk Management	Quality Management	Human resource planning
i^{th}	Human resource planning										1
	Quality Management									1	
	Technology Risk Management								1		
	Network Connectivity							1			
	Cloud resources						1				
	Technological competitors analysis					1					
	Cost management				1						
	Technological investment and capital management			1							
	Technology requirement handling		1								
	Technological categorization and planning	1									

Technology management dimension

	Certainty	Collaboration	Skills and expertise	Business Acceptance	Benefits	Compatibility with existing values and practices	Perceived ease of use	Perceived usefulness	Job Security
Job Security									1
Perceived usefulness								1	
Perceived ease of use							1		
Compatibility with existing values and practices						1			
Benefits					1				
Business Acceptance				1					
Skills and expertise			1						
Collaboration		1							
Certainty	1								

Employee and culture dimension

	Business cases	Strategic leadership	Business opportunity	Budget	Executive support
Executive support					1
Budget				1	
Business opportunity			1		
Strategic leadership		1			
Business cases	1				

Organizational governance and leadership dimension

	Agile delivery	Technology prospect/forecasting	Technology roadmaps and scenarios	Observable results	Business clarity	Trial-ability
Trial-ability						1
Business clarity					1	
Observable results				1		
Technology roadmaps and scenarios			1			
Technology prospect/forecasting		1				
Agile delivery	1					

Strategy dimension

	Infrastructure platform	Services	Information networks	Communication networks	Technologic sustainability and position map
Technologic sustainability and position map					1
Communication networks				1	
Information networks			1		
Services		1			
Infrastructure platform	1				

Infrastructure Dimension

	Technology identification and selection	Technology knowledge management	Enterprise resource planning in terms of databases and software	Return on investment	Agent based applications	Management information system and data processing
Management information system and data processing						1
Agent based applications					1	
Return on investment				1		
Enterprise resource planning in terms of databases and software			1			
Technology knowledge management		1				
Technology identification and selection	1					

Knowledge and information management dimension

This section involves the elements of the readiness dimensions. It is important to note that the importance of the technology elements should be evaluated with the focus on the implementation of artificial intelligence into the business.

Identify the weighting/importance of each element in the readiness dimension according to the Likert scale. Please enter the importance rating on a scale of 1 to 7. The descriptions can be seen in the table below.

Intensity of importance	Definition
1	Very Low importance
2	low importance
3	Low - moderate importance
4	Moderate importance
5	Moderate - strong importance
6	Strong importance
7	Very strong importance

Readiness dimension and element		Importance Rating (1-7)
Technology management	Human resource planning	
	Quality Management	
	Technology Risk Management	
	Network Connectivity	
	Cloud resources	
	Technological competitors analysis	
	Cost management	
	Technological investment and capital management	
	Technology requirement handling	
	Technological categorization and planning	

Employee and culture	Job Security	
	Perceived usefulness	
	Perceived ease of use	
	Compatibility with existing values and practices	
	Benefits	
	Business Acceptance	
	Skills and expertise	
	Collaboration	
	Certainty	
Organizational governance and leadership dimension	Executive support	
	Budget	
	Business opportunity	
	Strategic leadership	
	Business cases	
Strategy	Trial-ability	
	Business clarity	
	Observable results	
	Technology roadmaps and scenarios	
	Technology prospect/forecasting	
	Agile delivery	
Infrastructure	Technologic sustainability and position map	
	Communication networks	
	Information networks	
	Services	
	Infrastructure platform	

Knowledge and information management	Management information system and data processing	
	Agent based applications	
	Return on investment	
	Enterprise resource planning in terms of databases and software	
	Technology knowledge management	
	Technology identification and selection	

Thank you for your time!

Appendix I

*Note: This survey will be done via an online platform or physical administration and this document only indicates the format and nature of some questions that will be asked. It is also subject to minor changes. Elaboration of each element is not provided due to it being administered to subject matter experts.

Dear participant

Thank you for your participation as part of the research involved in completing my Master's degree in Engineering Management. The title of the study is," Development of an AI readiness model to assist in the implementation of artificial intelligence in business".

The aim of the survey is to provide the interviewer with performance evaluations with regards to the case study. This model was developed to assist in the implementation of artificial intelligence into the business. The survey is administered to different SMEs (subject matter experts that specialize on different dimensions in business and technology) and management. This aims to create a more balanced and complete result.

The signed institutional permission form for conducting interviews is attached. The participation in this study is completely voluntarily and the participant is free to withdraw from the study without any negative consequences. If the participant wishes to withdraw from the study, the data gathered from the specific participant through the interview/survey will be permanently deleted/destroyed. The participants are also free to refuse to answer questions they do not feel comfortable with. Data generated/obtained from this survey is anonymous. Any personal information disclosed within the survey answers will be used anonymously.

Principal investigator: M. Nortje (MEng Engineering Management candidate) – 18485189@sun.ac.za

Supervisor: Prof S. Grobbelaar – ssgrobbelaar@sun.ac.za

The purpose of this survey is to gather performance evaluations with regards to the case study. The survey covers seven large business readiness dimensions/themes, each with a set of elements/components. The readiness model was developed through a combination of models namely, technology readiness model, technology organization environment framework, diffusion of innovation, technology acceptance model, employee readiness and more literature. This artificial intelligence readiness model is generic in nature, thus applicable to and for a range of case studies and subject matter experts.

Section 1:

For this section, the interviewee needs to rate the performance of each readiness element to best of their ability with regards to their institution and with a focus on artificial intelligence implementation in the organization. Please rate a score from 1 to 10. 1 being extremely low/unimportant and 10 is extremely high/important.

Readiness dimension		Readiness dimension	Performance (1-10)
Technology management	Human resource planning	Documentation of data regarding the short to long term goals of the AI project	
		regarding the identification of the types of resources, people and competencies that will be required	
	Quality Management	Identification and selection of quality management structures for AI	
	Technology Risk Management	Assign responsibilities and roles for managing risks involving AI	
		Prioritisation and identification of information system assets	
		Implementation of practices and controls to mitigate risks	
		The identification and assessment of the likehood, as well as the impact of current and emerging threats, vulnerabilities and risks	
		Implementation of periodic improvement/update and monitoring of risk assessment to include changes in systems, as well as operating/environmental conditions that could affect the risk analysis	
	Network Connectivity	Identification of required network connectivity within business for AI	

	Cloud resources	Identification and selection of cloud computing models, such as infrastructure as a service, Platform as a service or software as a service	
		Identification and satisfaction of requirements regarding Cloud computing models	
		Identification and selection of cloud computing deployment models, such as cloud, hybrid and on-premises models	
		Identification and satisfaction of requirements regarding cloud computing deployment models	
	Technological competitors analysis	Technological competitors analysis for AI	
	Cost management	Identification of cost management structures for AI	
	Technological investment and capital management	Allocation of Investment and capital management for AI	
	Technology requirement handling	Identification of technology requirement management structures	
	Technological categorization and planning	Technological categorization and planning progress for AI	
	Job Security	Employees' perception on job security with regards to AI	
	Perceived usefulness	Employees' perception on the usefulness of AI	

Employee and culture	Perceived ease of use	Employees' perception with regards to ease of use of AI	
	Compatibility with existing values and practices	Compatibility of AI with business values and practices	
	Benefits	Employees' perception on the benefits regarding AI	
	Business Acceptance	Perceived business acceptance of AI	
	Skills and expertise	Perceived current skills and expertise capability to implement and manage AI	
	Collaboration	Willingness of employee collaboration with regards to AI	
	Certainty	Employees' perceived trust/certainty in AI	
Organizational governance and leadership dimension	Executive support	Executive support regarding AI	
	Budget	Allocation of a budget for AI	
	Business opportunity	Identification of applicable business opportunities for AI	
	Strategic leadership	Identification of strategic leadership, which comply with the activities and characteristics of a strategic leader	
	Business cases	Identification of business cases for AI	
Strategy	Trial-ability	Capability to conduct a certain amount of testing (test data)	
	Business clarity	Perceived business clarity with regards to AI	
	Observable results	Identification of methods and criteria involved with generating observable	

		results during testing/implementation of AI	
	Technology roadmaps and scenarios	Identification of technology roadmaps and scenarios regarding AI	
	Technology prospect/forecasting	Identification of technology forecasting methods for AI	
	Agile delivery	Development of the agile strategy with regards to AI	
Infrastructure	Technologic sustainability and position map	Development of the technology sustainability and position map for AI	
	Communication networks	Identification of communication networks involved with operation of AI	
	Information networks	Identification of information networks involved with implementation, operation and management of AI	
	Services	Identification and mapping of services that will incorporate AI	
	Infrastructure platform	Identification of required infrastructure in terms of cloud resources, as well required additional infrastructure sections	
	Management information system and data processing	Initiation of the development of management structures for information systems and data processing	

Knowledge and information management	Agent based applications	Conducting agent based simulations or modelling to indicate possible impacts of AI on business processes	
	Return on investment	Calculations of the return on investment for AI	
	Enterprise resource planning in terms of databases and software	Initiation of enterprise resource planning (databases and software) for AI	
	Technology knowledge management	Initiation of technology knowledge management strategies for AI	
	Technology identification and selection	Analysis of technology compatibility, system impact of AI and the maturity of the AI	
Security	Cyber security	Identification and development of management of cyber security with regards to Artificial intelligence	

Appendix J

Legend	Description
CAT1	The full document must freely available to researcher
CAT2	Only include english written literature
CAT3	Applicability of study towards the focus of this project
CAT4	Academic robustness of paper
CAT5	Academic conference reviews, lecture notes, presentation are excluded.
✓	Pass criterion
×	Fail criterion

Study Title	Selection criteria				
	CAT1	CAT2	CAT3	CAT4	CAT5
A science mapping approach-based review of construction safety research	×	-	-	-	-
Inner parameters' optimization in the artificial neural network for the traffic data classification in radiofrequency applications: Classification of nonstationary data using the machine learning algorithm "random forest"	×	-	-	-	-

Employee readiness for acceptance of decision support systems as a new technology in E-business environments; A proposed research agenda	✓	✓	✓	✓	✓
Assessing industry 4.0 readiness of enterprises	×	-	-	-	-
Challenges arising from prerequisite testing in cybersecurity games	✓	✓	×	-	-
Predicting extubating readiness in extreme preterm infants based on patterns of breathing	×	-	-	-	-
The challenge of advanced model-based FDIR for real-world flight-critical applications	✓	✓	×	-	-
The ML test score: A rubric for ML production readiness and technical debt reduction	✓	✓	✓	✓	✓
Autonomous cars - Pipe dream or reality for India customers	×	-	-	-	-
Cybersecurity Policies and Their Impact on Dynamic Data Driven Application Systems	×	-	-	-	-

Application driven inverse type constraint satisfaction problems	✓	✓	✓	×	-
Combat aircraft effectiveness assessment using hybrid multi-criteria decision-making methodology	×	-	-	-	-
Big data analytics by automated generation of fuzzy rules for Network Forensics Readiness	✓	✓	✓	×	-
Cloud based patient prioritization as service in public health care	×	-	-	-	-
RAAF - M1: UNSW Canberra - Royal Australian air force space situational awareness and ISR pathfinder mission	×	-	-	-	-
The semantic web as a platform against risk and uncertainty in agriculture	×	-	-	-	-
Cyber-healthcare for public healthcare in the developing world	✓	✓	✓	×	-

Work in progress - New education model based on competencies of higher education and iMIS with architectures	×	-	-	-	-
Research on Technical Readiness Evaluation Method in Model Development	×	-	-	-	-
An Extensible Framework for Predictive Analytics on Cost and Performance in the Cloud	×	-	-	-	-
Bringing ecosystem services indicators into spatial planning practice: Lessons from collaborative development of a web-based visualization platform	✓	✓	✓	×	-
Readiness model for industry 4.0 - The path to digital transformation [Article@Reifegradmodell industrie 4.0 – Der weg zur digitalen transformation]	×	-	-	-	-
Onset of global synchrony by application of a size-dependent feedback	×	-	-	-	-
Cloud readiness assessment framework and recommendation system	✓	✓	✓	✓	✓
Microsourcing Job Provider Maturity Model	✓	✓	✓	×	-

Towards a web based modelling and simulation tool for research, engineering and education in the field of hydrogen and fuel cell technology	×	-	-	-	-
To be a proper non-representational theory of perception, the sensorimotor approach must be a fully non-representational theory of behaviour	×	-	-	-	-
Integrated water management for municipalities in South Africa	✓	✓	✓	×	-
Heart failure risk models and their readiness for clinical practice	×	-	-	-	-
Machine learning based diagnosis support for shipboard power systems controls	×	-	-	-	-
Emotion as morphofunctionality	✓	✓	✓	×	-
Fuzzy cognitive maps as decision support tools for investigating critical agile adoption factors	×	-	-	-	-

System life prediction algorithm design and data analysis of inertial navigation	×	-	-	-	-
Information behavior in stages of exercise behavior change	×	-	-	-	-
Complex decision making experimental platform (CODEM): A counter-insurgency scenario	×	-	-	-	-
Improvement of business processes performances through establishment of the analogy: Quality management system -human organism	×	-	-	-	-
A demonstration of the transition from ready-to-hand to unready-to-hand	✓	✓	✓	×	-
A fuzzy logic based green information technology readiness model	✓	✓	✓	✓	✓
Agents, availability awareness, and decision making	✓	✓	✓	×	-
Technology Readiness Model for Enterprises	✓	✓	✓	✓	✓
Optimum maintenance scheduling for complex systems using mixed integer linear programming	×	-	-	-	-

An ongoing study of group treatment for men involved in problematic internet-enabled sexual behavior	×	-	-	-	-
Selecting and developing suppliers for mass merchandisers	×	-	-	-	-
Hybrid natural language generation in a spoken language dialog system	×	-	-	-	-
Proceedings: IEEE Systems Readiness Technology Conference	×	-	-	-	-
Model-based health tracking	×	-	-	-	-
Bringing knowing-when and knowing-what together: periodically tuned categorization and category-based timing modeled with the Recurrent Oscillatory Self-Organizing Map (ROSOM)	✓	✓	✓	×	-
Establishing a data-mining environment for wartime event prediction with an object-oriented command and control database	✓	✓	✓	×	-

Artificial intelligence for turboprop engine maintenance	×	-	-	-	-
Intelligent telemetry simulator for space applications	×	-	-	-	-

Appendix K

Study Title	Quality criteria		
	Completeness of document	Methodology	Aim/Goals
Digitalization Canvas – Towards identifying digitalization use cases and projects	✓	✓	✓
Neural networks: An overview of early research, current frameworks and new challenges	✓	✓	✓
An enterprise risk management knowledge-based decision support system for construction firms	✓	✓	✓
Determination of Rule Patterns in Complex Event Processing Using Machine Learning Techniques	✓	✓	✓
Research on quality measuring of CMMI cyclic implementation in software process	✓	✓	✓
Managing quality in outsourcing of high-end services: A conceptual model	✓	✓	✓
A model to assess open government data in public agencies	✓	✓	✓
Computer-aided warehouse engineering (CAWE): Leveraging MDA and ADM for the development of data warehouses	✓	✓	✓
A development process of KMS based on systems engineering methodology	✓	✓	✓

Appendix L

Legend	Description
CAT1	The full document must freely available to researcher
CAT2	Only include english written literature
CAT3	Applicability of study towards the focus of this project
CAT4	Academic robustness of paper
CAT5	Academic conference reviews, lecture notes, presentation are excluded.
✓	Pass criterion
×	Fail criterion

Study Title	Selection criteria				
	CAT1	CAT2	CAT3	CAT4	CAT5
Tracking the evolution of OGD portals: A maturity model	×	-	-	-	-
Embedding augmented reality applications into learning management systems	×	-	-	-	-
Digitalization Canvas – Towards identifying digitalization use cases and projects	✓	✓	✓	✓	✓
Neural networks: An overview of early research, current frameworks and new challenges	✓	✓	✓	✓	✓
An enterprise risk management knowledge-based decision support system for construction firms	✓	✓	✓	✓	✓

A Systems Analysis of the Introduction of Unmanned Aircraft into Aircraft Carrier Operations	×	-	-	-	-
On the role of the new pattern of communication of intelligent algorithm in modern exhibition marketing	×	-	-	-	-
Assessment of maturity levels in dealing with low probability high impact events	×	-	-	-	-
Knowledge elicitation and mapping in the design of a decision support system for the evaluation of suppliers' competencies	✓	✓	✓	×	-
Determination of Rule Patterns in Complex Event Processing Using Machine Learning Techniques	✓	✓	✓	✓	✓
Micro sourcing Job Provider Maturity Model	×	-	-	-	-
Test process improvement with documentation driven integration testing	×	-	-	-	-
HLA as an experimental backbone for autonomous system integration into operational field	×	-	-	-	-
Experiences and practices in the implementation of IT Governance in Mexican electric utility	×	-	-	-	-

Approaching ETL conceptual modelling and validation using BPMN and BPEL	×	-	-	-	-
A guide to implement open data in public agencies	✓	✓	✓	✓	✓
DSS-CMM: A capability maturity model for DSS development processes	×	-	-	-	-
Collective intelligence model for knowledge management in technology-based clusters	×	-	-	-	-
Research on quality measuring of CMMI cyclic implementation in software process	✓	✓	✓	✓	✓
Managing quality in outsourcing of high-end services: A conceptual model	✓	✓	✓	✓	✓
A model to assess open government data in public agencies	✓	✓	✓	✓	✓
Developing a knowledge process quality model evaluation system using commonkads	×	-	-	-	-
Methodology to evaluate the performance of simulation models for alternative compiler and operating system configurations	✓	✓	✓	×	-

The role of four-hour blocks in promoting active learning strategies: The impressions of students and teachers	×	-	-	-	-
32nd International Conference on Information System 2011, ICIS 2011, Volume 3	×	-	-	-	-
32nd International Conference on Information System 2011, ICIS 2011, Volume 4	×	-	-	-	-
32nd International Conference on Information System 2011, ICIS 2011, Volume 1	×	-	-	-	-
Hybrid OCR techniques for cursive script languages - A review and applications	✓	✓	✓	×	-
Computer-aided warehouse engineering (CAWE): Leveraging MDA and ADM for the development of data warehouses	✓	✓	✓	✓	✓
Apply fuzzy ontology to CMMI-based ASAP assessment system	×	-	-	-	-
ETL process model for a manufacture cells production line integration	×	-	-	-	-
A development process of KMS based on systems engineering methodology	✓	✓	✓	✓	✓

Computational aspects of cognition and consciousness in intelligent devices	✓	✓	✓	×	-
A stage model for NPD process maturity and IKMS implementation	×	-	-	-	-
Optimisation by clonal selection principles	×	-	-	-	-

Appendix M

Study Title	Quality criteria		
	Completeness of document	Methodology	Aim/Goals
Digitalization Canvas – Towards identifying digitalization use cases and projects	✓	✓	✓
Neural networks: An overview of early research, current frameworks and new challenges	✓	✓	✓
An enterprise risk management knowledge-based decision support system for construction firms	✓	✓	✓
Determination of Rule Patterns in Complex Event Processing Using Machine Learning Techniques	✓	✓	✓
Research on quality measuring of CMMI cyclic implementation in software process	✓	✓	✓
Managing quality in outsourcing of high-end services: A conceptual model	✓	✓	✓
A model to assess open government data in public agencies	✓	✓	✓
Computer-aided warehouse engineering (CAWE): Leveraging MDA and ADM for the development of data warehouses	✓	✓	✓
A development process of KMS based on systems engineering methodology	✓	✓	✓