

Critical Success Factors for Centres of Academic Excellence in Information Assurance

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Abstract

A literature review of Critical Success Factors (CSFs) was conducted and found a number of papers on a variety of related topics, but no definitive research into the specific area of Critical Success Factors for Centres of Academic Excellence in Information Assurance. This meant a meta-analysis methodology could not be used, and either an “Exploratory Factor Analysis” (EFA) or a “Confirmatory Factor Analysis” (CFA) approach would be appropriate.

Based on one of the most relevant papers found, a CFA approach was taken which involved conducting a survey of subject matter experts (in this case the academic staff involved with the Centres of Academic Excellence (CAE) at their academic institution). Due to a lower than expected response rate, this research should be considered as a pilot study. The initial findings show that the survey lacked validity due to not meeting goodness of fit modeling requirements. Exploratory Factor Analysis was then conducted to determine which if any factors could be found. The results show that there were six factors which can be appropriately named as “People and Culture”, “Employee Recognition”, “Program Design”, “Training”, “Management commitment”, and “Career monitoring”.

The future work from this thesis is to conduct further research with those six factors based on a larger sample of respondents. It is intended that the results can then be generalised to countries outside of America.

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^{*} Not his actual name and not to be confused with any real “Paul Nathan”s at the University of Otago, or in New Zealand or elsewhere for that matter.

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1 Introduction

1.1 Introduction

This thesis determines the “Critical Success Factors” in developing and deploying a Centre of Academic Excellence quality degree program in Information Assurance.

1.2 Key definitions

There are a number of key terms that will be used often in this thesis.

Academic institution: As explained in Section 2.3 on page 5 the term “school” is often used for tertiary institutions in America, however “school” is often used to refer to primary or secondary education such as “high school” in New Zealand or sometimes as either a collection of departments (or one specialized department) at Universities such “Otago Business School”. Therefore the term “academic institution” has been selected to mean any tertiary institution in either America or New Zealand.

America: While the full country name is “The United States of America” and it is located predominantly on the “North American” continent, the term “America” has been used in this thesis to describe the country.

Centre of Academic Excellence: A designation awarded to an American academic institution who have met specific criteria as outlined by the American “National Security Agency”.

Critical Success Factor: “Those things that must be done for a company to be successful”. Freund (1988a). For this research organization or academic institution is an acceptable substitute for company.

Factor Analysis: “a way to condense (summarise) the information contained in a number of variables into a smaller set of new, composite dimensions or variates (factors) with a minimum loss of information” (Hair, Black, Babin, Anderson, & Tatham, 2006, pg. 107)

Information Assurance: “Measures that protect and defend information and information systems”. A fuller description is in the glossary (page 85).

School: For this research School is used to mean any tertiary academic institution in America.

A full glossary can be found starting on page 85.

1.3 Research Objectives and Methodology

The main research objective of this research is to determine the Critical Success Factors (CSFs) for deploying Information Assurance degrees of a Centre of Academic Excellent level of quality. While there is a large amount of research into Information Assurance degrees and in Critical Success Factors and their analysis, there has not been any published research at the union of those topics.

Currently Information Assurance is only taught at CAE level in America, but as other researchers have noted, countries such as Australia and New Zealand have been planning on deploying such courses.

There is a rich body of Critical Success Factor research in other areas, predominantly in the Business field, which have established methodologies. Those methodologies can be classified into two main types, and the statistical analysis chosen usually matches the type of methodology used. One of the main types of methodology is to conduct an appropriate literature review of CSFs in related fields and then survey subject matter experts in the chosen field. For this research the subject matter experts would be the academics at the American Centres of Academic Excellence in Information Assurance.

A secondary research objective is to determine from those schools that are not CAEs what factors they consider either important or unimportant.

1.4 Contributions

Because this research is at the union of Information Assurance, Education and Critical Success Factors there are number of places the research can be presented and published. One of the most appropriate forums for the research is the Colloquium for Information Security Systems Education (CISSE).

The contributions are:

- 1) Determine the Critical Success Factors for American Schools for implementing the Information Assurance degrees
- 2) Determine the factors that schools that do not have Centres of Academic Excellence consider to be important or unimportant
- 3) Optionally consider if there are any geographical reasons
- 4) Optionally consider differences between America and NZ

1.5 Structure

The remainder of this thesis is structured as follows.

Chapter 2 presents the background material. Topics covered include the different types of tertiary academic institution in America and how they differ with those in New Zealand, the basics of Information Assurance and the requirements for schools to be accredited with CAE status.

Chapter 3 presents the literature review. That literature considers the Critical Success Factors derived from Business, Knowledge Management and Education and then considers the main methodologies used to determine those factors.

Chapter 4 presents the methodology. This chapter also considers the statistical methods used to analyse the data and the deployment of the survey.

Chapter 5 presents the analysis of the data and considers which of the factors were considered most critical.

Chapter 6 presents the conclusions, considers which factors are most critical and presents topics for future work.

2 Background

2.1 Introduction

This chapter presents the background information that is useful for understanding what Information Assurance (IA) is, the types of academic institutions there are in America, the history and need for Centres of Academic Excellence in Information Assurance, and the different types of certification that American academic institutions can apply for.

This chapter also briefly introduces Critical Success Factors which are then discussed more in-depth in the next chapter.

2.2 What is Information Assurance?

The American “Department of Defense” defines Information Assurance as (Department of Defense, 2004, pg. 9):

“Measures that protect and defend information and information systems by ensuring their availability, integrity, authentication, confidentiality, and non-repudiation. This includes providing for the restoration of information systems by incorporating protection, detection, and reaction capabilities.”

Definitions for availability and the like are available in the glossary. In general the definition (especially when applied to computer systems) means: is the information able to be accessed, is the person or system accessing it allowed to access it, and if changes have been made to the information can it be guaranteed to have been made by the person who made the changes.

The second part of the definition “protection, detection and reaction” refers to being able to prevent the information from being changed by the wrong or inappropriate person, detecting if a change has been made and what to do in situations if information has been changed, either correctly or incorrectly.

Cooper et al. (2010) state the important of Information Assurance as (pg. 110):

IA is of both national and international significance because of the increased reliance of governmental, military, and financial functions on complex interconnected computer systems and networks. These systems not only store information, they exchange and

process information and are involved in increasingly significant decision processes that demand all aspects of information assurance.

2.3 American Educational system

American is a federal republic, meaning it is a collection of states (48 contiguously in North America, with Alaska, and the island state of Hawaii for a total of 50) and one federal district (Washington D.C aka the District of Columbia) (Wikipedia, 2014c). While the individual states have some autonomy there are federal laws that apply to all states. There are a number of ways academic institutions can be differentiated, firstly how they are funded (the main focus of this section) but also if they are gender inclusive, nonsectarian or not, racially inclusive and the type of degree programs they offer. Of main interest to this research is the funding models and type of degrees offered, however it should be noted that one of the CAEs is “Howard University” which is a “historically black” university, and another is “DePaul University” which is a private catholic university. There is another category of academic institutions in America which is the “federal academy” which are administered at the federal level rather than state level and is discussed below.

2.3.1 State/Public funded

As the name implies, “State Schools” are academic institutions that receive funding from the state they are located in. Because of their public nature, each state has at least one “State School” with examples including “University of Alabama” in Alabama, “Florida State University” and “Florida International University” in Florida. In some of the larger states there are also “State University Systems”. A *state university system* normally means a single legal entity and administration, but may consist of several institutions, each with its own identity as a university (Wikipedia, 2014a). As an example the Texas State University System (TSUS) has eight institute members including “Texas State University” and “Lamar University” (Wikipedia, 2014b).

2.3.2 Private Funded

As the name implies, a privately funded academic institutions is one that does not receive direct state or government funding. They can be operated by non-profit organisations (especially religious organisations such as DePaul university mentioned on the previous

page) or can be operated “for profit”. As another example there is the “National Florida University” in Florida.

One of the commonly held differences between public and private schools is that public schools generally have lower tuition fees when compared to private schools.

2.3.3 Federal academies

Federal academies are funded by the Federal government rather than the state governments. Five of the federal academies are militarily orientated with an academy for Army (WestPoint), Navy (Annapolis), the Coast Guard, Air Force and Merchant Navy. Other federal academics include the FBI training academy, and Law Enforcement (Wikipedia, 2013). In the case of the military academies, the entry requirements include receiving a nomination from the congress (state level representative) of the potential student (known as a cadet) and other militarily requirements such as (West Point, 2014):

- Be at least 17 but not older than 22 on July 1 of the year they enter West Point.
- Not be married.
- Not be pregnant.
- Not be legally responsible for support of any children.

The main reasons for those requirements are because the cadet, if they graduate, gains both an academic qualification and a military commission and therefore potentially could be deployed internationally.

2.3.4 Types of degree offered

At the undergraduate level two of the main types of degree offered by American academic institutions are an “Associates degree” which is a two year course often offered by community colleges and the other is the bachelor’s degree which is typically a four year degree and is generally offered by polytechs, colleges and universities.

2.3.5 Comparisons to NZ

It is intended that this research can provide pointers for New Zealand academic institutions who wish to implement CAE style IA programs. As such the main difference between the American and New Zealand education systems are at present, in New Zealand the universities and polytechs are all publically funded and there is no direct analogue of the military academies. Universities typically offer three year undergraduate degrees with some

specialised courses such as the Law degree offered by the Otago University which is a four year degree. Polytechs offer a range of diplomas and degrees which can range from 6 months to three years in duration.

2.4 Centres of Academic Excellence in Information Assurance

A brief history of Centres of Academic Excellence in Information Assurance is presented by Cooper et al. (2010). They consider that 1987 and 1998 as two of the most important years for Information Assurance with the “US Computer Security Act 1987” being one of the main influences on Information Assurance Education (pg. 111). That law was designed to improve the security and privacy of sensitive information on federal computer systems, establish minimum security practices and mandated contingency plans and required annual training and awareness for system users (pg. 111). Most importantly for IA education however was the requirement that the NSA work with NIST to provide awareness training and education (pg. 111). 1998 was an important year because the “Centres of Academic excellence in Information Assurance Education (CAE/IAE) program was formed by NSA to recognize institutions with significant IA education programs, and to encourage other institutions to develop such offerings” (pg. 112). As part of the process of ensuring excellence, institutions had to apply for the status, show their courses mapped to the CNSS standards and importantly re-apply for certification initially every three years, which had been changed to every five years (NSA, 2014a).

2.4.1 Types of certification

During the time of writing this thesis there was a transitional period between the three main types of certification an academic institution could apply for, “CAE/IAE” (Centre of Academic Excellence, in Information Assurance Education), “CAE/R” (in research) and “CAE/2Y” (A two year program, such as the Associates degree, typically for community colleges) and the new certification of CAE IA/CD (Information Assurance and Cyber Defense).

This section presents the older style of certification as it was current at the time of writing and the newer CAE IA/CD had not been awarded to any academic institutions.

Cooper et al. (2010) states that the CAE/IAE status is based on Committee on National Systems Security (CNSS) standards (pg. 112). The main standard required by all CAE/IAE

certification holders was CNSS standard 4011 and it is recommended that other standards such as 4012 and 4013E are also met. The American National Security Agency (NSA) maintains a list of the standards met by the various CAE/IAE certified academic institutions (NSA, 2013). The first CAE/IAE certifications were awarded to seven academic institutions in 1999 (Cooper et al., 2010, pg. 112). The CAE/R designation was added in 2008 to recognise “excellence in IT innovation and Research” (Cooper et al., 2010, pg. 112). It should be noted that in 2004 the NSA partnered with the American Department of Homeland Security (DHS) in running the certification program.

In the transition to the CAE IA/CD certification the NSA/DHS has released the new requirements (NSA/DHS, 2013). Those requirements now use terms such as “Knowledge Units” and “Focus areas”. As an example in the CAE 2Y certification as a “Knowledge Unit” is “Cyber Defense” with topics such as “Malicious activity detection / forms of attack” and the outcome as “Apply cyber defense methods to prepare a system to repel attacks”. Optional “Knowledge Units” include “Data structures” with topics including “Strings, Lists, Vectors, Arrays” and “Searching and Sorting” and outcomes such as “Students will be able to discuss the advantages and disadvantages of different data structures/formats” (NSA, 2014b).

2.4.2 Criticisms of CAE in IAs.

Noted computer security research Professor Gene Spafford (aka Spaf) of Purdue University presented a strong criticism of the Centres of Academic Excellence in Information Assurance program in a blog originally posted September 18th 2008 (and updated in 2012) titled *Centres of Academic ... Adequacy* (Spafford, 2008). Spafford’s criticisms include the number of centres of excellence, the standards may not be appropriate for academic institutions, the potential resources on offer and the time taken for certification.

Expanding on his main points, he considered that while there were 94 centres of academic excellence in reality in his view there were only 12 centres of real academic excellence and the rest were closer to centres of academic adequacy as per the title of the blog post. He explains this further by pointing out the CAE requirements are more minimum standards and that there is a huge disparity between the resources and facilities of the academic institutions that do have CAE status. (Spafford, 2008)

The second point Spafford makes is that the standards used as the basis of the CAE certification (the CNSS standards) are, in his words, training standards rather than

educational standards and in some cases a one day course would meet the requirements.(Spafford, 2008)

The third point is that as of 2008 while it has been suggested resources (especially in the form of extra funding) would be available for CAEs that in his view those resources were never actually made available. (Spafford, 2008) He also points out that it does take a reasonable amount of time and effort to apply for certification and to ensure the academic institutions meets the certification standards.

His fourth point is that because of the third point in particular, the renewal process is a burden. (Spafford, 2008)

Normally it may be easy to ignore the criticisms of one person (especially when they present those criticisms in blog format) in this particular case it makes sense to take them at face value. Amongst Spafford's many achievements, accolades and appointments is that he has served on the President's Information Technology Advisory Committee (PITAC) (2003-2005) (NITRD, 2005a). PITAC had the stated goals of (NITRD, 2005b)

“The Committee provides the President, Congress, and the Federal agencies involved in networking and information technology research and development with expert, independent advice on maintaining America's preeminence in advanced information technologies, including such critical elements of the national information technology infrastructure as high performance computing, large-scale networking, cyber security, and high assurance software and systems design.”

This definitely lends credibility Spafford's criticisms and they will be incorporated in the survey instrument used in this research. At least one of Spafford's criticisms has been addressed by the CAE IA/CD certification no longer requiring a direct mapping to the CNSS standards.

Bishop and Taylor (2009) also present some criticisms of the CAE program. They assert that if the mere measure of success of the CAE program is “producing more computer security professionals who have been exposed to information assurance” (Bishop & Taylor, 2009, pg. 1) then yes, the CAE program would be successful. Bishop and Taylor however go further by asking if the CAE program has met other goals such as has it increased the number of faculty in the field, and is it actually improving the state of computer security and information assurance in America (pg. 2). In their analysis Bishop and Taylor, much like

Spafford, consider the process of becoming a CAE is in their words “annoying” (pg. 3) as the process of mapping the CNSS standards to the courses being taught is “extremely time consuming” and needs to be repeated when applying to be recertified (pg. 3). Also with Spafford’s second concern, Bishop and Taylor note that “undergraduate and graduate courses differ significantly in purpose and content from professional training standards” with regards to what is being taught and how it is being measured. The second major criticism Bishop and Taylor have also echoes Spafford’s third point in the lack of resourcing explicitly for academic institutions in the areas of “administrative overhead, security research or faculty development” (Bishop & Taylor, 2009, pg. 4).

2.5 What are Critical Success Factors?

The term used in this thesis is Critical Success Factors (CSFs), although other authors may use the similar term “critical factors for success” or “success factors”. In this section the overall concept of CSFs will be introduced with only a few examples given as Chapter 3 the literature review addresses the concepts in greater depth.

The original concept of CSFs was credited to Daniel (1961) and refined by Rockart (1982). Daniel (1961) introduces the concept with a brief history that shows that companies (especially those operating internationally) had need to appoint “program managers” or “product managers” who were tasked with determining why projects were running over budget and over time, how budgets and costs in one country may affect the project in other countries and the like (pg. 111). He states it quickly became apparent that while “outstanding men” were appointed to those roles, they lacked the information they needed, and potentially lacked the knowledge to know what information they needed. (pg. 111). As Daniel observes the reason for this was “obvious” that the companies had “inadequate management information” (pg. 111) and therefore there needed to be a mechanism or solution to this. As Daniel also notes (pg. 119):

“the evolution of electronic dataprocessing systems, the development of supporting communications networks, and the formulation of rigorous mathematical solutions to business problems have provided potentially valuable tools to help management attack its information problems.”

So CSFs were to some degree a solution for management information problems where managers needed to know what information was critical to the success of a particular product or problem. This and the evolution of CSFs are discussed further in chapter 3.

When applied to business executives, Rockart explained CSFs as (Rockart, 1982, p. 4):

“Those few key areas of activity in which favourable results are absolutely necessary for a particular manager to reach his or her goals”

Freund, when considering Rockart’s work, has a more succinct definition that CSFs are (Freund, 1988b, p. 20):

“Those things that must be done for a company to be successful”.

Freund(1988) asserts six fundamentals for CSFs which are (pg. 20):

- Important to achieving overall corporate goals and objectives.
- Measurable and controllable by the organization to which they apply.
- Relatively few in number – not everything can be critical.
- Expressed as things that must be done – not the end of the point of the process.
- Applicable to all the companies in the industry with similar objectives and strategies.
- Hierarchical in nature – some CSFs will pertain to the overall company, while others will be more narrowly focused in one functional area.

As will be shown in the next chapter, CSFs can be applied to other fields outside of business and so some of Freund’s definitions can be read as “functional area” rather than organization or company.

In his research Rockart raised one particular concern that (1982, p. 4)(pg. 4):

“Since any definition of the objectives, critical success factors, and operating methods of a ‘model’ I/S executive must be **subjective**, we elected a research method that was case based and inductive” (emphasis added)

That concern will be addressed later in the next chapter. The techniques which researchers use to determine the critical success factors are discussed in part in chapter 3 and more in-depth in chapter 4.

2.6 Conclusion

This chapter has presented some of the more important and useful concepts for this thesis such as what Information Assurance is, the genesis of the Centres of Academic Excellence in Information Assurance for educational institutions, the types of academic institution in America and also presented a strong criticism of the Centres of Academic Excellence in Information Assurance program. The chapter also introduced Critical Success Factors which are addressed more in-depth in the next chapter.

3 Literature review

3.1 Introduction

This chapter considers Critical Success Factor research across a variety of disciplines in order to determine the main methodologies and any challenges in conducting such research.

This chapter first considers the origins of CSF research and then the broad disciplines of Business with specific fields such as Total Quality Management (TQM) presented, Knowledge Management (KM) and Education. There will be some consideration of other fields that CSF research has been applied to such as Humanitarian Supply Chain challenges.

It should be noted that there is a breadth and depth to CSF research that means papers included in this chapter are more to highlight specific concepts or ideas and should not be used to indicate the relative popularity of a particular methodology or research question.

As a note, EFA (Exploratory Factor Analysis) and CFA (Confirmatory Factor Analysis) are used sparingly in this chapter to describe the analysis methods certain researchers used. The mechanisms and meanings of those analysis techniques are described in Section 4.3 on pages 34 and 35. Simply put however, CFA is used where a researcher has designed a survey with questions that they believe have an existing relationship hence “confirming” whereas EFA “explores” the relationships in order to ‘reduce the data’ down into specific factors.

3.2 Origins of Critical Success Factors (CSF)

The term used in this thesis is Critical Success Factors (CSFs), although other authors may use the similar term “critical factors for success” or “success factors”. The original concept of CSFs are credited to Daniel (1961) and refined by Rockart (1982) in a traditional business sense.

Forster and Rockart (1989) produced an annotated bibliography of CSF research with approximately 200 annotated CSFs for business. In their introduction they present an interesting argument that Critical Success Factors have been considered for well over two thousand years in one context or another (pg. 1). They present observations from Aristotle, Baron von Clausewitz (“a bad general scatters his troops across the battlefield and good general focuses on the few areas important to winning the battle”) (pg. 1) and Drucker (“a good executive focuses on a small number of critical problems or opportunities, the rest is delegated”) (pg. 1) as part of that argument. Forster and Rockart (1989) then explain the

current evolution of CSF research and considerations, that firstly CSFs were a tool for singular managers to consider their own information needs, that grew into management teams considering their information system priorities and finally into management teams considering their whole organisation's managerial needs (pg. 2). As the literature review shows, the concepts and techniques of CSF can be applied to other areas and other problems that are not strictly "managerial" in nature.

3.3 Considerations in CSF research

There are a number of considerations in conducting CSF research. Those considerations include methodological, interpretation and practical implementation considerations.

In his research Rockart raised one particular concern that (Rockart, 1982, p. 4, pg. 4):

"Since any definition of the objectives, critical success factors, and operating methods of a 'model' I/S executive must be **subjective**, we elected a research method that was case based and inductive" (emphasis added)

This is one of the bigger challenges when considering CSF research. There are a number of ways the subjective element creeps into CSF research ranging from the choices of questions to be asked, the way the questions are worded, if researchers decide to "group" their questions into scales to measure factors, or treat the factors independently, if any meta-analysis to other CSF research has been applied and the like.

Another important consideration is Freund's 3rd fundamental (Section 2.5 on page 10) which is "Relatively few in number – not everything can be critical" and that of not confusing CSFs with "Key Performance Indications" (KPIs). The example given Freund (1988b, p. 20) is "Achieving an 8% growth in new business is a measure of performance, but it is not a critical success factor – it is a way the results are to be measured, not a description of how things are done".

Another more practical consideration for CSF research especially for those conducting survey based CSF is that not all papers are clear on either the statistical analysis used, the questions in their survey or the overall meaning of their analysis. For experienced researchers this may not be a problem but for newer CSFs researchers it can be daunting to try and understand the research and to potentially replicate that research.

Fortune and White (2006) present two criticisms of CSF research, those being (pg. 54)

“The first is that the inter-relationships between factors are at least as important as the individual factors but the CSF approach does not provide a mechanism for taking account of these inter-relationships.”

To support this argument they cite Belassi and Tukul’s example of “Top Management” being a factor and also “Project manager competency” as another factor and while individually if one fails the project still might succeed, but if both fail then the project likely fails (Fortune & White, 2006, pg. 54)

The second criticism Fortune and White (2006) present is (pg. 54):

“the factor approach tends to view implementation as a static process instead of a dynamic phenomenon, and ignores the potential for a factor to have varying levels of importance at different stages of the implementation process.”

In the strictest sense in this research, the aim is to find the Critical Success Factors for implementing a Centre of Academic Excellence in Information Assurance with the assumption the academic institution already has a degree program in place and are applying for CAE status. More broadly however, the CAEs have to contend with being re-certified and there may be cases where academic institutions decide to create an entirely new degree program that would likely meet the CAE certification requirements. While Fortune and White’s criticisms will be taken into consideration when the research is conducted it may not be possible to adequately address the second criticism, especially as some CAEs have been certified for over 10 years.

3.4 Applications of CSF research

While CSF research was predominantly focused on business and business processes the methodology has been applied to a number of other areas. This section examines the CSF research in Business and Education as they are the most relevant to this research with a caveat that some forms of CSF research much like the Information Assurance field itself is multi-disciplinary. Section 3.4.3 “CSFs for other types of problem” on page 24 considers the other types of research that examines CSFs, including “Knowledge Management”. Examples

of “other types of problem” include Pettit and Beresford (2009) who examined “Critical success factors in the context of humanitarian aid supply chains” which could be seen either as “Business” CSFs since it deals with supply chains, or “humanitarian aid” which is quite different from business. Likewise Ika, Diallo, and Thuillier (2012) researched “Critical Success Factors for World Bank Projects” which shares elements of pure business but also charity or crisis solving.

3.4.1 CSFs in Business

As mentioned earlier, Forster and Rockart (1989) produced an annotated bibliography of business orientated CSF research. One of the benefits of their bibliography is the number of ways they classify the bibliography in matrix format. Examples include their “Table Two Concepts” which has “Historical antecedents”, “Basic concept”, “Method”, “Industry CSFs” and “CSFs role” as the x-axis and relevant articles as the y-axis (Forster & Rockart, 1989, pg. 17). From that they map “Von Clauswitz” as a “Historical Antecedent” (as mentioned in “Origins of Critical Success Factors (CSF)” on page 13) and map one of Rockart’s individually written articles as “Basic Concept”, “Method” “CSFs role”. Another matrix Forster and Rockart use is “Table 3 Uses” with “Mgmt Info Needs.”, “Info systems planning”, “Strategic planning and Strategy implementation”, “Executive Info systems”, “Project and program mgmt” and “Other” as the x-axis and authors listed by last name only as the y-axis (Forster & Rockart, 1989, pg. 18). Examples of the “uses” include “Rockart” as “Mgmt. Info. Needs”, “Rockart, Crescenzi” as “Info systems planning” and “Munro, Wheel” as “Mgmt. Info. Needs” and “Info systems planning”. The matrix approach would have been useful if used by other researchers when they presented the basis for their decisions as this literature review will show.

Finally the bibliography then presents the article or paper name with an abstract or similar description of the paper. A good example of this is (pg. 26):

Baxter, John D. "Managers: What's Critical to Your Success?", Iron Age,

Vol. 226, No. 5, February 16, 1983, pp. 37-39.

The CSF approach, now gaining wide acceptance, has given rise to a new line of questions for many managers. CSFs, often implemented as part of a larger effort to develop manufacturing information and control systems, can also be used alone. It is easy to grasp, quick to implement, and centers on the manager and his job. As useful

to small companies as to large, the CSF technique works best with upper-echelon executives. CSFs are not effective, however, at the level of first-line supervisor because their scope of responsibility is just too narrow. (abridged)

Before the growth of the Internet and arguably easier access to journal articles, an annotated bibliography like this would have been an excellent starting point for further research. As it stands, it is still a great guide for quickly finding relevant business related CSFs research. The only minor criticism of their work is there is no table or matrix for methodology elements such as data collection or statistical analysis done. Knowing which article used a paper based survey or a case study approach could be useful for other researchers.

Saraph, Benson, and Schroeder (1989) is considered one of the more important articles for this thesis, while they focused on “quality management” as a purely business approach, it has been incorporated into the academic environment by Bayraktar, Tatoglu, and Zaim (2008) (discussed in section 3.4.2 CSFS in Education on page 19). Saraph et al. (1989) base their research problem in an almost similar way to Daniel (1961). Where Daniel was concerned with management information, Saraph et al. (1989) observe that American firms are being challenged by products of superior quality from international competitors (pg. 810) and that while there is plenty of literature about descriptions of quality concepts and quality improvement programs there is the lack of “systematic attempt to organise and synthesize the various prescriptions offered, nor have measures of organisational quality management been proposed” (pg. 810).

Saraph et al. (1989) then present an impressive literature review explaining various recommendations of Quality management professionals, and notes that those recommendations are generally personal observations of those professionals (pg. 813). Additionally some of the authors they had referenced considered the CSFs to be “people orientated” such as “employee motivations and rewards” (pg. 813) whereas others considered “product design” and “quality planning” (pg. 812) to be the critical factors.

Saraph, Benson et al.’s study aims to be the first empirical study to merge the recommendations and determine the critical factors. They then considered 120 items from the literature as being potentially relevant to determining their factors which were later changed to 78 questions conducted in a survey, which they analysed with EFA. This led to determining eight factors with analysis suggesting one of the factors “process management” could be split into two factors (pp. 822-823). One of the strengths of their work is the clear

way in which they present the rationale for their methodology, the depth of their literature and the relative clarity of their analysis. Although their research was primarily focused on quality management, two of their factors “training” and “top management leadership” are likely to be relevant to this research.

Antony, Leung, Knowles, and Gosh (2002) consider the Total Quality Management (TQM) CSFs for Hong Kong in particular. Their methodology considered not only Saraph et al. (1989) but three other researchers not included in this research [Black and Proter 1996, Tamini 1998, Joseph et al. 1999] and present the number of scales and items that those researchers had considered. As such Black and Porter had eight factors and 66 items, Tamini had ten factors and 32 items and Joseph et al. had ten factors with 106 items (pg. 553). This reinforces that while there are some recommended minimums there are generally not specific guidelines for CSF research in terms of number of questions/items or number of potential and actual scales.

One of the more interesting things with Antony et al. (2002) is that in their methodology when conducting their literature review they present the factors determined by the previous researchers in a list. A matrix approach could have shown the factors that one or more of the previous researchers had found. As such, manually looking through the list shows that three of the four previous researchers considered “training” as a CSF. Things can then get difficult due to the subjective nature of some of the factor labelling, or because of how the research was conducted that sometimes factors are split into sub-factors. As an example, Antony et al. (2002) state one researcher determined “Top management leadership” as a factor, and another researcher had “Top management commitment” and “Supervisory leadership” as two factors (pg. 554). This points to the potential challenge of the subjective nature that Rockart (1982) warned of, and that other researchers may potentially find or name factors they consider to be unique to their work, that may in fact have been identified by other researchers but with slightly different names.

As for their sample size and response rate Antony et al. (2002) mailed out 400 surveys and had a response rate of 66 surveys (16.5%). They identified seven factors using an EFA approach as Saraph et al. (1989) and like Saraph, Benson et.al their reliability analysis recommended deleting a number of items from the scales. Of note, four of the scales ended up with either 2 or 3 items in them after deletion and curiously one scale started with only 2 items in it. This suggests that it can be acceptable to have a survey that has less than six items

per scale. As can be reasonably expected, in their results they determined that the CSFs included “training” and “management commitment”.

Song, Podoyntsyna, Van Der Bij, and Halman (2008) were concerned with the success factors for “new ventures” specifically “New technology ventures” (“NTV”) and their methodology differs somewhat from many of the others in this research. They used a meta-analysis approach which firstly considers the prior research only (in their case 31 studies [from 106 studies after suitable criteria was used to remove certain studies] with a combined total of 24 success factors (pg.10). The methodology for meta-analysis then follows a number of steps to allow for testing between studies of different sample sizes and potential measurement errors (pp. 10-11). An apparent benefit of this methodology is the ability to potentially differentiate and condense down the meta-factors into universal factors which would likely solve the problem outlined with Antony et al. (2002) that “training” was found across the studies they had examined, but “management leadership” and “supervisor commitment” were not as universal.

The research of Song et al. (2008) is also considered interesting and relevant for this research given they are looking at success factors in new technology ventures, and it is reasonable to consider that CAEs in IA could also be considered a type of new venture. The meta-analysis methodology is however not considered appropriate for this research at this stage as there does not appear to be enough research in the specific field of CSFs for CAE in particular and in course creation of this type in general.

3.4.2 CSFS in Education

There have been a number of papers considering Critical Success Factors in education. The majority of them consider online education or e-learning such as (Mazzarol, 1998; Odunaike, Olugbara, & Ojo, 2013; Selim, 2007; Soong, Chan, Chua, & Loh, 2001; Volery & Lord, 2000). The papers in this section are presented in chronological order.

Mazzarol (1998) was concerned with “Critical success factors for international educational marketing” which is considered as potentially relevant for this research but with marketing as a secondary concern. One of the considerations for CAEs in IA may be how they attract their students from “in state” or “out of state” and potentially internationally. The factors that Mazzarol derives however are of definite interest for this research. Mazzarol’s methodology

was to survey 1255 educational institutions (including secondary schools) across Australia, New Zealand, Canada, America and the United Kingdom in 1994 with a paper based survey (pg. 167). He had a respondent rate of 315 usable surveys (25%) and there is no mention of endorsement, enticement or other methods to increase the response rate. Based on the types of respondent he received (75% had been in the educational environment as an employee for 10 or more years, and 75% had frequently been involved in planning decisions) (pg. 168) he was confident he was dealing with subject matter experts. Mazzarol's methodology was then to ask the respondents to rate the performance of international marketing using a 7 point Likert scale (measuring performance could be seen as a form of criterion validity (further explained in Section 4.3.4 on page 31)).

One of the more interesting aspects of Mazzarol's work is that he had 17 items (considered reasonably low by some other authors) and a high population that he sampled. As part of his initial results reporting, he only reported means rather than means and standard deviations (margins of error were also not reported, however that can be calculated from the sample size and response rate) which may not necessarily produce the full picture of results. Of note however "encourages innovation" was the highest with a mean of 5.67 out of a possible 7, "is highly successful at recruiting and retaining quality experienced staff" (5.64), "is technically superior to most in its field" (5.15) and "has a very strong and active Alumni" (3.52) (pg. 168) were also interesting items that may be relevant to this research.

Mazzarol then conducted EFA analysis to determine there were four main "success factors" of "promotion and recruitment", "image and resources", "people and culture" and "coalition and forward thinking". It is important to note that EFA analysis generally shows which items (in this case 17) relate best together, it does not name the factors themselves. An additional element of Mazzarol's research that makes it stand out from some other papers is that he then conducted case studies of 14 institutions after determining the factors to further understand if they were correct and applicable (pp. 171-172).

Volery and Lord (2000) were focused on online education as it was "a new paradigm of education" (pg. 216) at that time. Of note in their methodology they surveyed the 47 students enrolled in "Global Business 650" using an anonymous questionnaire asking a total of 28 items spread across "technology" "instructor characteristics" and "student characteristics" (pp 216-217). They found a total of six factors after using an EFA/PCA approach. The division into "technology" and then "characteristics" makes the research interesting especially as the

factors for “instructor characteristics” were “attitudes towards students”, “instructor technical competence” and “classroom interaction” (pp. 220-221). It is conceivable that “instructor technical competence” (or a variation of it) may be relevant to the CAE for IA factor analysis, as IA is a potentially highly technical area and competence would therefore be important.

Soong et al. (2001) investigated the CSFs for online course resources. Their approach involved using a case study approach of interviewing academic staff (three, one for each module that (Soong et al., 2001) considered relevant) and surveys of the students in two of the modules. Their research consisted of four main factors (“Human factors” “Technical competency” “Mind-set” and “Collaboration”) and their conclusions suggest that under “Technical competency” that “both instructors and students must be IT savvy” as an example. Soong et al. (2001) assert that their findings fit the “Technology Acceptance Model (TAM)” but their paper does not explain the analysis to support that. Their paper is therefore interesting as another way to conduct CSF research and into a specific type of research question of “course resources” but as other papers show, there are other methods that use more statistical analysis which may be more appropriate for this research.

Selim (2007) was interested in e-learning acceptance and his research can be seen as a follow up in part to Volery and Lord’s research. This is more pronounced as Selim used a survey with “instructor characteristics” as one of the four main factors (“technology”, “support” and “student characteristics” being the other three), and replicated 11 of the 13 items from Volery and Lord (pg. 400), and eight indicators for “technology” also duplicated from Volery and Lord. From a methodological approach, Selim had a large response rate (538 responses of 900 surveys deployed or 60%) and five scales with 53 items across them. Unlike some of the other researchers, Selim included both the means and standard deviations as part of the descriptive statistics, and because the scales were already determined, Selim used a CFA approach. The other benefit to newer CSF researchers is that Selim included both the survey questions and a diagrammatic approach to the analysis.

From Selim’s analysis while he had initially anticipated there would be four factors the analysis suggested there were eight. The factor of “Support” was determined to be valid with validity testing, and “Instructor characteristics” needed to be divided into two factors due to four of the items better relating together as “The instructor’s style and control of the e-learning tools” (Selim, 2007, pg. 404). This shows that while the researcher can create a good

and appropriate survey that there can be unexpected or “better” relationships found when the data is collected and analysed. Selim used a 5 point Likert scale but the questions did differ in ways from some other researchers as “some questions were negatively worded” (pg. 401) whereas many other researchers use only positively worded questions.

Bayraktar et al. (2008) take a slightly different approach as they were more concerned with Total Quality Management (TQM) in Turkish Higher Education. As such, their paper is a mix of both business and educational research. Their paper is highly beneficial to newer CSF researchers as it clearly lays out the methodology and more importantly fully describes the statistical analysis undertaken. It also includes the survey instrument (list of questions) in their appendices which is not always the case with other researchers.

Bayraktar et al. examine specific educational elements in their instrument with “Program design” and “Student focus” being two important considerations, and “Education and Training” also being important. Other elements they examined are more typical of the business CSFs discussed earlier such as “Leadership”, “Vision” and “Process control and design” (pp. 556-559). Their survey instrument used a five point Likert scale “1 – strongly disagree to 5 - strongly agree” with close ended questions. They identified 11 “scales” across a total of 61 items (questions) and used the CFA methodology which attempts to “confirm” the items have been correctly assigned to the scales by the researchers, whereas EFA “explores” the items in an attempt to determine which items best relate together in potential scales.

The following are some of the relevant examples of questions they asked purely relating to education. They are presented with the scale number, and then the number within that scale such as Scale 5, Question 2. (Bayraktar et al., 2008, pp. 572-573):

Scale 5: Program Design

2. The experienced academicians’ suggestions are thoroughly considered in the design of curriculum.
3. The needs and suggestions from the business world are thoroughly considered in the design of curriculum and new academic programs.
4. Curriculum and academic programs are evaluated and updated every year.

Scale 10: Student Focus

1. Our university collects student complaints and evaluates them carefully.
2. Our university conducts a course-evaluation survey for every course taught in each semester regularly.
4. Our university has some organised efforts on continuous education of our students for their business-life and personal development after graduation.

Other questions that are likely to be relevant to this research include

Scale 1: Leadership

9. University top management pursues long-term stable performance instead of short-term temporary solutions.

Scale 3: Measurement and evaluation

2. Our university benchmarks our academic and administrative processes with other institutions.

Scale 4: Process control and improvement

2. Our university meets the expectations of our students and employees.

Conversely there are some questions from their survey which are less likely to be relevant to this research such as:

Scale 4: Process control and improvement

1. Our university is kept neat and clean at all times.

Overall, Bayraktar et al. (2008)'s paper is considered by this author as one of the more relevant and important papers for this research. While this research does not relate to TQM issues, their paper does consider a variety of topics, and analyses it with what this author believes to be appropriate and relevant questions.

Odunaike et al. (2013) concern themselves with the CSFs of e-learning implementation. What makes their research different from many of the other researchers is they use the “living theory methodology” which they describe as (Odunaike et al., 2013, pg. 3):

“Living theory methodology can be seen in practical sense as either narrative or phenomenological or grounded theory or Ethnographic or case study or as an action research plus the living “I”.

The theory places emphasizes on the uniqueness, inventiveness, self-study and creativity of individual in devising educational theories based on their own intuition, observations, practices, studies, influences and experiences toward improving knowledge and general practice from within historical and social-cultural perspective of our daily walks of life and work. The living theory methodology presents the action researcher with platform such as action reflection cycle to explain their claim or educational problems, why and how they intend to solve their problems using the living theory approach.”

The paper itself is interesting and it serves more as a set of CSFs for the actual implementation of a Centre of Academic Excellence. Due to the lack of statistical analysis and reflective nature presented by Odunaike et al. the “Living theory methodology” is rejected as a suitable methodology for the research in this thesis.

3.4.3 CSFs for other types of problem

There have been a number of other areas that the CSF methodology has been applied to. This section firstly considers “Knowledge Management” as a domain, and then particular research questions.

Chong (2006b) considered the Critical Success Factors for Knowledge Management implementation. To understand what Knowledge Management (KM) is they state that (pg. 133) :

“KM is a broad subject which encompasses a wide range of disciplines that include, but not limited to, cognitive science, communications, individual and organisational behaviour, psychology, finance, human resource management, strategic planning, systems thinking, process reengineering, systems engineering, computer technologies and software and library sciences”

This is followed by the observation that “because of the multi-disciplinary nature of KM, the proposed CSFs are fragmented and diversified” (Chong, 2006a, pg. 133). Likewise this author considers KM to be more than just a set of business CSFs and potentially likely to have relevance to the CSFs of CAEs that business CSFs might not. While typically business related CSFs are reported by Chong such as “top management leadership and commitment” factors such as “knowledge friendly culture”, “removal of organisational constraints” and “knowledge structure” appear more applicable to education, or at least academic institutions in certain circumstances. While CAEs do have proscribed requirements for certification (which could be seen as organisational constraint) those requirements are seen as minimums and the academic institutions are able to go beyond those requirements.

Jafari, Akhavan, Nour, and Fesharaki (2007) considered the CSFs for KM in the Iranian Aerospace field. This is another example of a specifically narrow research question or niche field that CSFs can be used in. Their research used a survey questionnaire initially with 31 questions, and similar to Antony et al. (2002) they had both a number of items to be deleted and a low number of remaining items on the factors that they determined via an EFA methodology. One of the more interesting results from their research that is distinctly different from Akhavan, Hosnavi, and Sanjaghi (2009) (the next article to be discussed) is that they found “job enrichment and security” to be a factor (Jafari et al., 2007, pg. 385). This can be seen as an example where two or three specific questions can form a factor relevant to the specific field, but may not necessarily be relevant to other related fields. This in turn can be the benefit of a meta-analysis methodology such as Song et al. (2008).

A very narrowly focused paper that initially is highly relevant to the research is Akhavan et al. (2009) who examined “Knowledge Management Critical Success Factors in Iranian academic research centers”. Their article was considered suitably different from education as it both dealt with KM but also as they focused on research centres rather than universities as Bayraktar et al. (2008) did. They used a survey approach, with factor analysis (similar to Saraph et al. (1989)) and sent out 420 questionnaires. Their response rate was an impressive 72% (301 valid surveys returned). Their findings were in line with some of the tenets of KM with “Human resource management and flexible structure”, “KM architecture and organizational preparedness for KM implementation”, “Benchmarking” as some of the factors (pp. 284-285). They describe “Benchmarking” as “continuous comparison with rivals” and that it could “lead to more productivity and higher performance” (pg. 285). Of

note Bayraktar et al. (2008)(pg. 572) considered “benchmarking” as a part of their “Measurements and evaluation” scale. So while not all their factors or questions will be relevant to this research it does suggest another approach and some considerations for this research.

When considering other types of research problems using the CSF methodology one interesting example is Pettit and Beresford (2009) who examined CSFs for supply chains in humanitarian aid (HA). Their main reason for doing this is (Pettit & Beresford, 2009, pg. 450)

“HA delivery is often treated as a series of discrete activities disconnected from each other and there is often a weak (or non-existent) connection between each stage in the delivery of aid, and developing continuous supply chains has not generally been a priority leading to large amounts of waste”

A secondary reason as their research showed is that while commercial supply chains have been researched, humanitarian aid (non-commercial) had not been researched (Pettit & Beresford, 2009). While their paper uses a meta-analytical approach (described in 4.2.1 “Meta-analysis” methodology on page 28) and does not have specific statistical analysis it does present an interesting way to apply CSF research to an interesting problem.

Shieh, Wu, and Huang (2010) present an interesting mixed methodology for their research into “key success factors of hospital service quality”. Their approach uses a literature review to determine 17 items, and then they surveyed hospital patients. The main difference in their research than from many others is they then apply the “decision-making trial and evaluation laboratory” (DEMATEL) method. They then performed, in their words, case studies with staff at the hospital where they had conducted the initial survey in order to rank the criteria they discovered. Based on Saraph et al. (1989) this would appear to be a form of criterion validity checking with extra evaluation steps. As it involved surveying patients and then surveying hospital staff, this author considers the analogue would be to survey students and then academic staff for CSFs in CAE of IA which has some logistical problems as well as potential practical problems. It is outside the scope of this research however it could make for potentially interesting future work.

Another paper which investigates a project management problem that is not strictly business orientated is Ika et al. (2012) who took an empirical approach to investigating CSF for World Bank projects. As it is empirical research their approach uses a survey and asked 41 questions (Ika et al., 2012, pg. 109). What makes their research more interesting than some others is that they also include “Project success measures” and mapped them to the five Critical Success Factors they found (pg. 109). To some degree this is also a form of “criterion validity” and would make for an interesting approach if academic institutions who were intending on gaining CAE status could be found to research both before and after.

3.5 Summary

As the literature review has shown, the CSF methodology can be applied to many types of research questions including those that can be broad such as “Total Quality Management” and very focused such as “Knowledge Management in Iranian Academic Research centres”.

Not only can the type of research questions be quite different, the methodologies used can also differ. Some researchers ask a broad number of questions to a reasonably small number of subject matter experts and others ask a relatively few questions to a wide range of subject matter experts. Likewise the response rates differ markedly from the mid-teens to the mid to high seventies. In part due to the different ways the researchers conduct their research there are often overlaps between the factors found (“training” and “management leadership” as examples) but also cases where the factors differ and the meta-analysis methodology can be appropriate to determine which factors tend to be more universal than others.

The methodology for this research is presented in the next chapter.

4 Methodology

4.1 Introduction

This chapter presents the methodology for the research based on considerations from the literature review of the different ways to conduct CSF research. Due to certain prior research such as Bayraktar et al. (2008) and others being more relevant to this research their methodologies were followed more closely. Using a survey instrument instead of case studies or other approaches used in CSF research (outlined in the next section) was the preferred method for this research so the chapter then continues with a discussion on the survey questions selected and the deployment of the survey. The analysis of the data collected from the survey is then presented in the next chapter.

4.2 Methodologies for CSF research

Within CSF research there are two main types of methodology, meta-analysis and survey instrument. As chapter 3 showed there are some other methodologies such as “Living theory” (Odunaiké et al., 2013) and “Decision-making trial and evaluation laboratory (DEMATEL)” (Shieh et al., 2010) which are considered outside the scope of this research as the first “Living theory” can be seen as reflective after the task has been accomplished, and the second would generally involve case studies after the initial survey has been completed. Case studies were considered but rejected for this research but do make sense as future work.

4.2.1 “Meta-analysis” methodology

Meta-analysis research generally involves defining the research question, conducting a thorough literature review, combining the results of relevant studies and analysing the combined results. As CSF research is multi-disciplinary and has been conducted for a reasonable length of time it is possible to conduct meta-analytical research on some types of CSF research questions. As noted earlier Forster and Rockart (1989, pg. 2) had considered over 200 publications in the general area of Critical Success Factors between 1979 and 1989.

Examples of meta-analysis include Song et al. (2008) who considered critical success factors for new technology ventures and arguably Chong (2006a) who analysed CSFs for Knowledge Management implementations.

4.2.2 “Survey/Instrument” methodology

As the name implies, the survey or instrument methodology uses an instrument such as a survey to query respondents such as subject matter experts on their views regarding the specific research question. There are many examples of this type of research for CSFs including (Bayraktar et al., 2008; Mazzarol, 1998; Volery & Lord, 2000).

4.3 Statistical analysis used in CSF research

One of the more interesting challenges for conducting CSF research is the many different ways researchers gather and then analyse their data. This section considers both the raw data collection and then the more commonly used statistical analysis methods and the additional validity tests some researchers conduct.

4.3.1 Data collection

Many of the researchers in the literature review use a survey approach, and most of those made it clear that they used a paper based survey either deployed manually or by post. Because some researchers do not clarify the actual deployment method it is possible they may have used an electronic survey. Conversely there was nothing in the literature that said that an electronic survey would not be appropriate and that only the paper based approach was appropriate.

As the literature review also showed, there was a wide range of response rates such as 12.5% (178 of 1421) for Ika et al. (2012) and 60% (538 of 900) for Selim (2007). The papers generally did not discuss any methods they used to increase the response rates (such as endorsement or enticement), partly because of the diverse nature of potential respondents.

Of the papers that use survey instruments, many use Likert scales. Likert scales provide a mechanism for respondents to rate their views or opinions on various questions. An example question might be “Our university is kept neat and clean at all times.” with acceptable answers as “1 strongly disagree; 2 disagree; 3 neutral; 4 agree; 5 strongly agree” (Bayraktar et al., 2008, pp. 571-572). Of the papers considered by this author most use a five point scale such as (Chen, Gillenson, & Sherrell, 2004; Chong, 2006b; Selim, 2007; Volery & Lord, 2000), Wong (2005) uses a six point, and (Bhatti, 2005; Ika et al., 2012; Ravesteyn & Batenburg, 2010) use a seven point scale. The six point scale (Wong, 2005, pg. 274) uses a “not successful at all” to “extremely successful”. Wong then re-encoded the scale into “poor”, “satisfactory”, and “good”. “Poor” comprised the “not successful at all” and “slightly

successful” scales; “moderately successful” and “successful” were denoted “satisfactory”; and “very successful” and “extremely successful” were taken as “good” (pg. 274).

One of the key benefits of using a Likert scale is the answers are already encoded into numeric values without having to interpret or guess what the respondent meant. This in turn allows for easier statistical analysis.

4.3.2 Analytical methods commonly used

Of the papers considered in the literature review there are two main types of analytical methods used for Critical Success Factor analysis: “Exploratory Factor Analysis” (EFA) and “Confirmatory Factor Analysis” (CFA). As their names suggest, EFA examines the items to determine how many scales the items can be assigned to and how to assign them “exploring” the relationships between items, whereas CFA “confirms” that items have been correctly assigned to the scales. The rationale for using EFA and CFA is explained first in the next section “Item Analysis”.

Often methodologies for factor analysis examine the reliability of the instrument and then the validity of the instrument using EFA or CFA techniques. Two of the main papers referenced in this research use one or both techniques.

4.3.3 Item analysis

Item analysis has been used by authors such as (Bayraktar et al., 2008; Saraph et al., 1989). Item analysis is described as “This is a method to check the appropriateness of the items assigned to the scales and it considers the correlation of each item with each scale”(Bayraktar et al., 2008, pg. 562). With this approach it is possible to determine if the item is in the correct scale, should be in a different scale, or should be removed from the instrument entirely according to Saraph et al. (1989).

As an example Bayraktar et al. (2008) found that in Scale 8 “Recognition and Reward” that the item of “Appointments to the administrative and academic positions are based on the necessary skills required by the positions” scored 0.461 in the “Item to score correlation matrix” which is below the 0.5 threshold and was therefore excluded. To further illustrate this point the other values in their matrix ranged from 0.7 to 0.965 so 0.461 was clearly lower than the rest (pg. 562).

Saraph et al. (1989) present a more in-depth example. They considered item 1 which is “Extent to which the top division executive (responsible for division profit and loss) assumes

responsibility for quality performance” across all of the 8 scales with scale 1 being “Role of divisional top management and quality policy”, scale 3 being “Training” and scale 4 “Product design” as examples (Saraph et al., 1989, pg. 822). The correlation values were .79, .52 and .27 for scales 1, 3 and 4. It is expected that item 1 would correlate most highly with scale 1 (the scale it was assigned to) which in this case it did. Likewise it not be expected that “Extent to which the top division executive (responsible for division profit and loss) assumes responsibility for quality performance” would correlate highly to “Product design” which at .27 it did not.

Similarly item 24 “Training in the ‘total quality concept’ (i.e. philosophy of the company-wide responsibility for quality) throughout the entire division” had been assigned to scale 3 “Training”. For scales 1, 3 and 4 the respective correlation values were 0.6, 0.77 and .35. This means that it was most suited for the training scale and not appropriate under the “Product design” scale (Saraph et al., 1989, pg. 822).

4.3.4 Reliability and Validity methods commonly used

Typically in CSF research there is the need for both reliability and validity methods to ensure that the survey instrument itself is appropriately constructed to measure the CSFs.

4.3.4.1 Reliability testing

With regards to reliability Saraph et al. (1989) assert that (pg. 820):

There are four main methods to assess the reliability of empirical measurements (1) the retest method, (2) the alternative form method, (3) the split halves method, and (4) the internal consistency method.

They further note that the first three methods either require administering the same instrument to the same group twice, or requiring two alternate forms of the measuring instrument. The fourth method “the internal consistency method” requires only one administration which suited their purposes, Saraph et al. (1989).

Cronbach’s Alpha is often used as a technique to measure reliability in an instrument. Bayraktar et al. (2008) outline that it is used to measure the internal consistency, and that it is based on the average correlation between items. Cronbach’s Alpha should be .70 or higher, but 0.5 or 0.6 can be acceptable. For this research 0.5 was considered the lowest minimum Cronbach’s Alpha that was acceptable.

SPSS (the commonly used name for the “Statistical Package for the Social Sciences” (IBM, 2013)) can produce a number of reports for correlation including measuring Cronbach’s Alpha using the appropriately named “Reliability statistics”. SPSS can generate the overall Cronbach’s Alpha for a number of items (generally the items in a scale, such as items 1-7 [questions 6-13 in the survey] in Scale 1 of this research) as well as two other important values “Corrected Item-Total Correlation” and “Cronbach’s Alpha if Item deleted”. “Cronbach’s Alpha if Item deleted” calculates what the Cronbach’s Alpha would be by deleting the item from the scale. If a “Cronbach’s Alpha if Item deleted” score is lower than the current Cronbach’s Alpha then it means the reliability would decrease and the item should not be deleted. If the “Cronbach’s Alpha if Item deleted” score is higher than the current Cronbach’s Alpha then it means the item should be considered for deletion.

“Corrected Item-Total Correlation” shows how much of an impact the item has on the scale overall. Bayraktar et al. (2008) use this value to build their “Item to scale correlation matrix” which is another mechanism to determine items for deletion.

SPSS can also be used to conduct EFA factor analysis (AMOS is recommended for CFA) which can be used for Validity testing. AMOS is a tool recommended for CFA factor analysis, and is described by IBM as (IBM, 2014):

IBM® SPSS® Amos enables you to specify, estimate, assess and present models to show hypothesized relationships among variables. The software lets you build models more accurately than with standard multivariate statistics techniques

- Provides structural equation modeling (SEM)—that is easy to use and lets you easily compare, confirm and refine models.
- Uses Bayesian analysis—to improve estimates of model parameters.
- Offers various data imputation methods—to create different data sets.

4.3.4.2 Validity

Saraph et al. (1989) (pg. 823) outline three types of validity testing in their research. Those are Content validity, Criterion-related validity, and Construct validity.

Bayraktar et al. (2008) (pp. 565-567) also used Content validity and Construct validity and as well as Convergent validity and Discriminant validity testing.

Content validity is essentially the process of ensuring that the content of the instrument is appropriate and by its nature is subjective. As an example for this research “Our academic institution’s top management allocates adequate resources for academic and administrative employee education and training” is likely to be a relevant question as appropriate resourcing especially in education and training of staff has been seen as important by Bayraktar et al. (2008). A less likely question might be “Our academic institution is kept neat and clean at all times”. Content validity can be achieved in part by consulting the appropriate literature, consulting subject matter experts (rather than conducting full case studies with them) and pilot testing the survey instrument in a variety of ways.

Criterion-related validity is described by Saraph et al. (1989) as also being known as “predictive validity” or “external validity” and they explain it further as “the extent to which a measuring instrument relates to an independent measure of the relevant criterion” (pg. 823). For this research it was decided that it would make more sense to focus on determining the CSFs and using criterion-related validity could be applied after that had been completed, rather than as part of this research.

Construct validity as described slightly differently by both Saraph et al. (1989) and Bayraktar et al. (2008) but essentially a construct is valid if it measures the theoretical construct it was designed to measure Saraph et al. (1989). Bayraktar et al. (2008)’s definition differs as it describes the process as being helpful in determining if there are any subscales within the same construct. Saraph et al. (1989) approach to Construct validity is to use EFA, while Bayraktar et al. (2008) uses both EFA and CFA. Bayraktar et al. (2008)’s rationale for using CFA is that their Content validity identified both items and scales, and that CFA is an appropriate way to determine if the items have been assigned to the scales correctly.

Convergent validity is described as “the degree to which two measurements of the same concept are correlated” (Hair et al., 2006, pg. 137) and furthermore that “High correlations indicate the scale is measuring its intended concept”.

Discriminant validity is described by Bayraktar et al. (2008) as “the degree which measures are unique from each other”. This is achieved by pairing up each scale and comparing the values. Bayraktar et al. (2008) results showed that with 11 scales they would be conducting 55 tests. Of those tests, 53 tests produced results that showed the required uniqueness, and because only 2 tests did not, they concluded there was appropriate discriminant validity.

As the methodologies, terminologies and techniques for both EFA and CFA can be more advanced than they need to be for this thesis, the reader is recommended Hair et al. (2006) (pp. 101-165) for further clarification. Hair et al. (2006) explain that a part of factor analysis is first (pg. 117):

determining the variance of a variable which in turn is “the square of the standard deviation” which represents the total amount of dispersion of values for a single variable about its mean. When a variable is correlated with another variable, we many times say it shares variance with that other variable, and the amount of sharing between just two variables is simply the squared correlation.

Hair et al. (2006) demonstrates this with “if two variables have a correlation of .50, each variable shares 25% (0.5 squared) of its variance with the other variable” (pg. 117). Finally Hair et al. (2006) clarifies that in factor analysis variables are grouped based on their correlations, so that variables have high correlations with each other (pg. 117).

Hair et al. (2006) then outlines three types of variance, “common” which is the amount that it shares with all other variances in the analysis and “communality” is the estimate of a variable’s shared or common variance. “Specific/unique” variance is variance associated only to that variable as it cannot be explained by correlations with other variables, and “error variance” which like “specific” variance is not explained by correlations with other variables but is due to unreliability in the data gather process, measurement error or a random component in the measured phenomenon (pg. 117).

4.3.5 Exploratory Factor Analysis EFA

Hair et al. (2006) describes EFA as (pg. 773):

“EFA explores the data and provides the researcher with information about how many factors are needed to represent the data. With EFA, all measured variables are related to every factor by a factor loading estimate. Simple structure results when each measured variable loads high on only one factor and has smaller loadings on other factors (i.e. loadings < .4). The distinctive feature of EFA is that the factors were derived from statistical results not from theory, and so they can only be named after the factor analysis is performed”.

In other words, the analysis itself will indicate how the variables correlate and which ones should be grouped together as factors. Once the analysis has been done then the researcher can assign appropriate names to the factors such as “leadership” or “vision”.

The techniques for EFA as explained by Hair et al. (2006) include “latent root” or “eigenvalue” criterion which states that factors that have an eigenvalue greater than 1 are considered significant and those less than 1 are not. The eigenvalues can then be used for Scree test criterion which graphs the eigenvalues and the number of factors (pp. 120-121). Factor rotations are then also applied either as orthogonal or oblique and as Hair et al. (2006) note (pg. 127):

“no specific rules have been developed to guide the researcher in selecting a particular orthogonal or oblique rotational technique. In most instances, the researcher simply utilizes the rotation technique provided by the computer program”

4.3.6 Confirmatory Factory Analysis CFA

Hair et al. (2006) (pg. 774) explain that unlike EFA, CFA relies on the researcher having already determined how many factors their instrument will have, and the items relating to those factors. This is the approach that Bayraktar et al. (2008) uses where they believed “Leadership” was a CSF, and that their questions such as “University top management (Board of regents, rector and associate rectors) is knowledgeable about TQM and its implementation.”, “University top management strongly encourages employee involvement in TQM.”, “University top management allocates adequate resources for academic and administrative employee education and training” would highly correlate to each other and potentially not highly correlate with any of the other questions they asked.

The CFA methodology can then test each factor to see if the variance of all the variables in that factor is explained by one factor. In other words, Bayraktar et al. (2008) tested the variance of the 9 items in “Leadership” and only one factor emerged because the items were highly correlated to each other.

Because CFA is a part of “Structural equation modelling” (SEM) the factors can then be tested with “goodness of fit” models to test the validity. Hair et al. (2006) state that while there are a number of goodness of fit models there are some common values and considerations. They note (pg. 805) that Chi-squared (χ^2), Comparative Fit Index (CFI) and Root Mean Square Error of Approximation (RMSEA) (pg. 748) are appropriate tools and are

available across the main SEM programs such as AMOS. The appropriate values for those goodness of fit tests are described in the next chapter as it deals specifically with the analysis.

4.4 Choices made for the methodology

The methodology for this research will be to use Content validity, Construct validity, Convergent validity and Discriminant validity following Bayraktar et al. (2008)'s methodology and using both the EFA and CFA approaches that they did. This is mainly due to the belief that their scales and factors are applicable to CAE in IA research and because if the scales themselves are not applicable, the validity testing in CFA approach will make that clear. If the CFA approach shows that the items are not assigned to the correct scales, EFA can be used to determine how many scales there are and which items should be associated with those scales.

4.5 Survey construction

There were a number of considerations for this survey, to either use paper based, telephone or electronic, the size of the survey and how to improve the response rate. There was also the minor consideration of which if any of the Centres of Academic Excellence to exclude from the list.

4.5.1 Survey type

Telephone surveys were rejected quickly due to the likely time taken per survey calculated at potentially 20-45 minutes per survey by the time introductions were made, follow up questions and potentially offerings of research collaboration. Additionally that would assume the respondent was readily available to undertake a telephone survey at that time which in turn meant it was likely scheduling either by telephone calls in advance or via email would need to have been done. Alternatively the interview would have to have been rescheduled. Finally, other than having someone else conduct the telephone surveys there would not be any anonymity involved which was considered an important factor for this research.

The second reason flows from the first, that assuming all respondents were keen and readily available and the surveys took 20 minutes apiece, it would take almost 160 hours (or 4 weeks at 40 hours a week). This would have strong cost implications (especially if the average survey took closer to 40 minutes than 20) in both time and money for international telephone calls. While Skype is a cheap or free service, the length of time to make the calls was considered prohibitive relative to the other available solutions.

Paper based surveys were initially considered for this research as they had been successfully used in a variety of other surveys this author and his supervisor had been involved in. There was one minor issue with the “time” factor that it was considered it would take approximately two weeks from the time the survey booklets were printed and sent to arrive with the intended recipients, and another two weeks to be returned. Adding in at least two weeks for the respondents to reply meant the process was expected to take six weeks and then the time taken for data entry had to be factored in as well.

Anecdotally from previous surveys that the author and his supervisor were involved with in 12 months before the survey for this research was conducted, feedback had shown that a number of respondents considered paper based surveys to be a “waste of resources” both in terms of paper and money and that they preferred to respond to electronic surveys. Some respondents from those other research projects stated they no longer responded to paper based surveys and only considered telephone or electronic surveys.

This left electronic surveys as the final option for this survey. The benefits included low to no cost to implement, the data did not need to be converted from a different source into an electronic source for processing and the low turnaround times in deploying the survey.

4.5.2 Improving the response rate

There are two ways in which the response rate can be improved “Endorsement” and “Enticement”. An international colleague who has been awarded certificates of recognition from CISSE (see page 1 or the glossary on page 85) for their expertise in the area of Information Assurance and Education was approached to endorse the survey. The colleague was more than happy to assist with the project and offered some valuable insights regarding the CAE process and considerations for the survey questions. Because of their keenness and reliability from other projects other endorsers were not approached. After some negotiations the colleague was going to send out an email directly after the CISSE 2014 conference (the date selected for the survey deployment) endorsing the survey. However due to unforeseen international travel the colleague was unable to undertake that, so the survey was sent out by the author with the colleague offering to endorse the survey when the follow up email was going to be sent. As a side effect of the unexpected international travel the colleague suffered a medical emergency which meant the endorsement could not be sent out then. For these reasons it was considered appropriate to leave the colleague as anonymous.

“Enticement” was considered but rejected. The main types of enticement considered appropriate for this research would have either been direct financial reward, indirect financial reward or access to the data set. It was estimated that the academics who would be receiving this survey would each have an hourly rate of \$40-80+ usd/hour. It was expected that the financial incentive would have to be reasonably in line with that hourly rate to make it worthwhile, and this also introduced issues of the financial exchange rate, processing any payments and maintaining the anonymity of the respondent and being able to identify them for payment.

Indirect financial reward such as entering a draw for a gadget or something New Zealand based were seen to have the same relative issues of a direct financial reward along with fairly selecting and notifying a winner. In both cases other than the financial resources actually needed it was considered it would potentially “cheapen” the survey and possibly negatively affect the response rate.

Another type of enticement can be access to the data set/results. This was implied in the cover letter and encouraged potential collaboration between the author, his supervisor and the respondent so it was not explicitly offered as an enticement.

4.5.3 The size of the survey

One of the other appeals of an electronic survey not included above was the size of the survey. It was considered when compared with a paper based survey, that an electronic survey could have more questions and could allow for branching. Branching means that if a CAE answered they did not have a CAE in Research then the survey “branched” and did not ask those respondents questions relating to research. As the Literature review showed, there is no set size or minimum number of factors or elements that CSF research requires. Mazzarol (1998) had 17 items and Antony et al. (2002) stated another researcher had over 100 items. However it has been recommended that each potential scale have at least three items associated with it (Raubenheimer, 2004, pg. 60), and ideally seven or more (Bayraktar et al., 2008; Saraph et al., 1989). Antony et al. (2002) had a number of scales that had four or less items per scale.

The decision was made that the survey should also include enough basic demographics questions to potentially allow comparisons between the respondents and to determine if there

were relevant issues such as “public schools” or “private schools” are more likely to choose certain answers when compared with the other schools.

4.6 Survey questions

The survey was designed to be in three sections, the first being demographics, the second the actual factors and elements and the third (“auxiliary”) to be any other considerations that may be relevant to the overall goal of creating and deploying a CAE in New Zealand or internationally.

The survey itself can be found in Appendix A (on page 87) and it should be noted as the survey was deployed electronically, there were minor changes to the layout as it appears on a computer screen than as it appears in the appendix. None of the questions were mandatory to make it easier for the respondents to complete the survey. Questions predominantly used radio buttons or tick boxes to ensure only one answer per question were entered.

4.6.1 Section One: Demographics

The first five questions were for demographic purposes. They were designed to differentiate potential respondents and allow potential additional analysis such as do publicly funded academic institutions respond differently or have different objectives than privately funded academic institutions. This was considered even more relevant as the main academic institutions in New Zealand at the time of writing are all publicly funded.

The second question asked which certifications the academic institution had. This was partly for further analysis with regards to the CAE/2Y (the two year ‘community college’ option) and for those who were a CAE/R (research) rather than education/teaching focused. This was important as New Zealand academic institution as described in Chapter 2 Background (page 6) are likely to either be CAE/2Y in the case of polytechs in general or a mix of CAE/IA and CAE/R in the case of universities and some polytechs.

Question four asked the breakdown of instate and out of state students and included international students for completeness. This served two purposes, the first to give an idea if local students were taking the CAE/IA courses and secondly if the respondent’s academic institution was attracting out of state students to their courses. This question had one interesting side-effect of identifying the academic institution from the District of Columbia (DC) as by definition all their students were “out of state”.

Question five gave the respondents the opportunity to mention which state their academic institution was located in, or the name of the academic institution. The survey was designed to be anonymous and while no methods were used to track the respondents (ip tracking and the like) it is likely that without question five it might have been possible to narrow down which respondents were affiliated with which academic institution. That analysis however was not done.

4.6.2 Section Two: Critical Success Factors

As stated earlier, this research is based in part on Bayraktar et al. (2008) and as such a number of their questions were duplicated in this survey. This was in part to allow comparisons between the two pieces of research and because while there is no directly relevant research in this area already, their research does present some useful guidelines.

The seven scales that were chosen for this research are presented in Table 1 below.

Table 1 The scales used for this research

<i>Scale 1 Leadership and Vision</i>
<i>Scale 2 Program Design</i>
<i>Scale 3 Staff Training and Education</i>
<i>Scale 4 Other Stakeholders' focus</i>
<i>Scale 5 Employee involvement</i>
<i>Scale 6 Recognition and Reward</i>
<i>Scale 7 Measurements and Evaluation</i>

These are similar to the ones used in Bayraktar et al. (2008) but with different numbering in some cases. Bayraktar, Tatoglu et al. also had *Quality system improvement* and *Process control and improvement* in their research which was not considered relevant to this research. Additionally this research compacted Bayraktar, Tatoglu et al.'s *Scale 1 Leadership* and *Scale 2 Vision* into one scale. While no new scales were added, there was a section three "auxiliary" that did cover other aspects of research.

To keep the survey easier to understand, continuous numbering between sections was used. In other words, the last question in Section 1 is 5, so the first question in Section 2 is 6. This is important to keep in mind when considering scales and items. Section 2 comprised of a total of 33 questions (numbered 6 to 38) with 21 questions being replicated from Bayraktar,

Tatoglu et al. Most of their questions used the term “university” which is replaced with academic institution in this survey. This also meant that two questions could be added that were duplicates of the Bayraktar, Tatoglu et al questions but used CAE as well as of academic institution. Table 2 below shows the mapping of questions in this survey with those replicated from Bayraktar, Tatoglu et al. (2008)

Table 2 Mapping of survey questions

Question number in this survey	This research	Bayraktar, Tatoglu et al. (2008)
6	Scale 1: Item 1	Scale 2: Item 1
7	Scale 1: Item 2	Scale 2: Item 3
10	Scale 1: Item 5	Scale 1: Item 8
11	Scale 1: Item 6	Scale 1: Item 9
12	Scale 1: Item 7	Scale 1: Item 6
15	Scale 2: Item 3	Scale 5: Item 5
17	Scale 3: Item 1	Scale 9: Item 1
18	Scale 3: Item 2	Scale 9: Item 2
19	Scale 3: Item 3	Scale 9: Item 4
21	Scale 4: Item 1	Scale 11: Item 1
22	Scale 4: Item 2	Scale 11: Item 2
23	Scale 4: Item 3	Scale 11: Item 3
25	Scale 4: Item 5	Scale 11: Item 5
26	Scale 4: Item 6*	Scale 11: Item 5
27	Scale 5: Item 1	Scale 7: Item 4
28	Scale 5: Item 2	Scale 7: Item 5
29	Scale 5: Item 3	Scale 7: Item 6
30	Scale 5: Item 4*	Scale 7: Item 6
32	Scale 6: Item 1	Scale 8: Item 2
35	Scale 6: Item 4	Scale 8: Item 4
36	Scale 7: Item 1	Scale 3: Item 1
37	Scale 7: Item 2	Scale 3: Item 2
38	Scale 7: Item 3	Scale 3: Item 7

* These questions are CAE specific versions of the question that is typically about the academic institution overall.

The remaining questions were based on other questions from the literature review or those deemed appropriate after discussions with the author's supervisor and other stakeholders. Examples include questions 8,9 and 14 (scale 1 item 3 and 4, scale 2 item 2) that relate to innovation which was considered important by Mazzarol (1998) and question 13 considers Spafford's concerns about the course design.

4.6.3 Section Three Auxiliary

There were eight questions (39-46) in Section Three. One of the reasons academic institutions might aspire to CAE status is the potential prestige that it brings, that it may affect the choice of students when choosing which academic institution to study at and that having worked or studied at a CAE previously may be of benefit to a new staff member.

Question 39 asks if having CAE status adds to the prestige of the academic institution and this is followed by Question 44 that the requirements of getting CAE status ensures a level of prestige.

The final question (46) in the survey was the only open ended question which encouraged the respondents to comment about the Critical Success Factors for CAEs in IA or other relevant thoughts. This was intended to capture anything that was not directly related to the factors, or to allow the respondents to comment about the CAE certification or process which could provide insights.

4.7 Deployment

This section considers the deployment of the electronic survey.

4.7.1 The mailing list

While there was no definitive mailing list available to non CAE members, the NSA does provide a list of all current CAEs (NSA, 2014c). The process was to create a spreadsheet that would contain the list from the NSA, with a contact person, contact email address, the CAE status of the academic institution and fields for any relevant notes. The mailing list was itself was created by following the urls provided by the NSA list and determine the most appropriate person at each CAE to respond to the survey. In most cases this was reasonably straight forward as one person at each CAE would have a title such as (programme) director or similar. In some cases there were no titles but the faculty list would indicate which staff

member worked predominantly in the area of Information Assurance. In a very few cases where neither of these were possible, the next step was to look for a general “Contact” address for the degree course, or CAE. It was decided it was preferable to contact a person rather than a group address, since the person could forward the email to another more suitable person, and while unlikely multiple people from one group address might answer the survey. Where no suitable group address or director could be found the head of department or other senior staff member was selected to be the recipient.

A benefit from taking this approach was it gave the author an insight to how each academic institution had organised their outward facing CAE status and information. Some of the sites were very professional, and designed to make finding the contact information easy whereas other sites did not seem as professional or kept up to date. Additionally there was the issue that in many cases the NSA list would link directly to the CAE information such as “[www.examplecae/caemainpage](#)”, whereas other times it would only link to the academic institution such as [www.examplecae](#) and further searching was required. This was occasionally problematic as institutions used different terms to describe Information Assurance and while many housed Information Assurance in “Information Assurance” or “Computer Science” departments some hosted it in “Electronic Engineering” departments and others hosted it in Social Sciences.

As an interesting side note, two of the websites put measures in place to make it difficult to harvest email addresses. The first measure was to have java script blocking the copying of text from the website, and the second showed a partial email address and used an ellipse “...” to mask the rest of the address. A user would have to click on the ellipse to see the full address. This measure was considered slightly strange as the email addresses for that academic institution were in the format of first initial, full last name @ academic institution so it could have been reasonably guessed.

The process of manually creating the mailing list also introduced some interesting ideas for follow up research around how academic institutions with CAEs decide their email naming schemes, how they protect and provide contact information (in some cases email addresses were not held on the academic institution at all) and how they provide other information to users. A secondary issue was the consistency of the links on the NSA website, and within the academic institutions as well meaning that many but not all links went directly to the CAE, with some cases the link just going to the academic institution’s main page.

4.7.1.1 Exclusions

After some consideration it was decided that it would be more appropriate to exclude the six “military school” academic institutes from the list of CAEs. This decision was primarily made for two reasons.

The first reason being there is no real direct analogue in New Zealand, of hybrid academic and military training facilities where the students/cadets would graduate with academic qualifications and military rank. The second reason is that the military schools are funded differently and have a different style of governance from the other American academic institutions and by extension from New Zealand academic institutions. The military schools would have been instructed to create their courses to meet the requirements of CAE status (and been funded to do that) whereas the other CAEs would have to have gone through a decision making process to determine if they wanted to achieve CAE status or not.

This left 173 academic institutions that would be surveyed.

4.7.2 The mail out

As noted earlier the initial plan was to have the endorser send out the initial email about the survey however this was not possible. The survey was sent out after CISSE 2014 in mid-June with an initial close off date of July 4th which would likely stand out to Americans as it is their “Independence Day” holiday. It was considered that the deployment date should be reasonably close to CISSE as that is one of the main conferences relevant to CAEs and that it would be fresh in the mind of the respondents. One downside to selecting the mid-June to early July timeframe is that it would be in the summer time for Americans and many respondents may be on holiday or otherwise engaged in work or research away from their main academic institution.

Once it was determined the endorser would also not be available to send out an endorsement or follow up email, the author sent out the follow up email. Because there had been 18 unique responses (approximately 10% response rate) it was decided to leave the survey open for an additional week when the follow up email was sent. After sending the follow up email there were an additional 9 unique responses raising the overall response rate to approximately 15%.

4.8 Summary

As seen from the variety of types of CSF research presented in the literature review there are a number of different ways to conduct CSF research. This chapter has considered the two main ways that research has previously been conducted with a focus on the survey instrument approach. Within the survey instrument there are then a number of ways of conducting the specific CSF analysis such as Exploratory Factor Analysis and Confirmatory Factor analysis being two of the preferred approaches. Within those analysis techniques researchers generally use reliability and validity analysis which were also outlined.

Once the methodology for how to conduct the analysis was described the methodology for the survey creation and deployment was also described.

5 Analysis of the Data

5.1 Introduction

This chapter presents the analysis of the data. A lower than expected response rate of initially 15% puts this research more into a pilot study than authoritative research. Other researchers such as (Ika et al., 2012) reported response rates of less than 15% for their surveys. Both Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) techniques were used for the analysis of the data. The chapter uses reliability metrics to consider which if any items and scales should be removed, and then uses validity to determine if the remaining scales are valid. Due to the relative comprehensive nature of the methodology there were no changes from it.

5.2 Preliminary examination of the data before analysis

Because the survey was deployed electronically on Otago University servers there was a mechanism in place for the author to see how many responses had been made, but not see the data until the survey had been closed off.

As part of the deployment process a number of emails were “bounced” back as invalid email addresses (4) or as “out of office” (8) with dates ranging from 2 days after the initial send out to an unspecified “Mid August”. One email was bounced back with a statement the person had retired and was replaced by another staff member. In the case of the invalid email addresses, the addresses were checked with the source urls to make sure there had not been any errors in copying or transcribing the addresses. In two cases where the addresses had to be transcribed there had been simple typo mistakes made, and these were rectified in the spreadsheet and then emails were sent individually to the corrected addresses. Likewise with the case of the replaced staff member, the new contact details were put in the spreadsheet. With the remaining two email addresses that were bounced back, they appeared to be correct according to the websites they came from. Follow up searches found an alternate email address for one of the respondents and that was used and the final address bounce back was attributed to the possibility the respondent mail server was down or otherwise not processing emails.

With the “out of office” emails, it was decided to leave them in the spreadsheet since replacing the respondents ran the risk of the same academic institution responding twice. This

was considered a reasonable risk since only three of the eight out of office replies stated they would be back in office during the period of the survey being open.

Two respondents emailed back with positive comments and offers for assistance or collaborative research and they were marked in the spreadsheet to not be sent the follow up email.

Initially there were 27 responses, and because there were no mandatory questions there was the potential issue of determining what constituted a valid survey. A survey was considered valid if the majority of questions in Section 2 were completed as they pertained directly to the Critical Success Factors.

Of the 27 surveys, one was removed as it was entirely blank. Two more surveys had all of Section 1 completed, but nothing else, and one survey had the first “page” of Section 2 completed but nothing beyond that. The decision was made to remove that response as well. This left a total of 23 valid responses.

The next checks of the data were to see if there were any respondents who appeared to have completed the survey more than once. While there was no guaranteed way to stop a respondent from completing the survey more than once as IP logging and blocking had not been enabled, there were enough fields in the demographics section to differential the respondents. As such Question 4 (origin of students, in state, out of state, or international) showed only one match of 90/5/5. Fortunately both respondents had answered Question 5 (A fill in box asking for which state they were in, or the name of their academic institution) and those answers were markedly different. Additionally there were no duplicates in Question 5 which would otherwise suggest that two or more people from the same academic institution had responded to the survey.

Arguably someone could answer multiple times with different answers however this seemed unlikely and other checks of the data did not show any runs of the same type of answer. Likewise while it was possible for a respondent to select the same answer for each question (essentially they either strongly agreed or strongly disagreed with everything) this did not happen either.

Across four responses there were nine unanswered “blank” values in Section 2 and Section 3 (not counting the fill in comments section). Those responses were not removed and where blanks were encountered the appropriate tables and calculations have notes.

5.3 Response rate

The response rate was calculated to be 15% (23 valid of 173 surveys sent out). While not directly comparable, Ika et al. (2012) (who surveyed World Bank projects) used a similar methodology and reported a 12.5% response rate, with their observations being similar to the experiences of this author (pg. 109):

“They are very busy, they travel extensively, they are often bombarded with questionnaires, and the World Bank blocks or filters many mass emails for security reasons. Therefore, many only received our email invitation after the second or third and final attempt. For the above reasons, we believe the real response rate to be near 30%.”

Other researchers such as Mazzarol (1998) reported response rates of approximately 25% and Volery and Lord (2000) stated they surveyed 47 students (assumedly 100% of a small group as they did not state the response rate).

Because Likert scales were predominantly used with “radio buttons” for answer selection there was no need for any recoding of the data for the factors and elements themselves. Question 46 which was an open ended fill in question which allowed the respondents to comment on the CAE process, or the survey itself is treated separately in Section 5.7 on page 72 of this chapter.

5.4 Margin of error

The margin of error was calculated based on the 23 valid surveys out of 173 surveys sent out and uses a 95% confidence interval. The margin of error is therefore $\pm 19.08\%$. Where respondent numbers are used this would represent ± 4.38 “responses” and has been rounded down to ± 4 responses.

It was hoped that with the appropriate endorsement that the response rate would have been closer to 60 or more respondents putting the margin of error at $\pm 10\%$. Because of the margin of error / response rate it makes comparisons between different demographics (public vs. private, in state vs. international students) either difficult to make or not relevant to make.

5.5 Actual analysis

SPSS 22 and *Amos 22* were the tools used for the analysis in this thesis.

As described in the methodology the first step is to conduct item analysis, and the first step of that is generating the descriptive statistics as shown in Table 3 below. While generally not a scale for this thesis “auxiliary” was included for consistency and ease of reference.

Table 3 Descriptive statistics of the survey results

		Items						
Scales		1	2	3	4	5	6	7
<i>Leadership and Vision</i>	Mean	3.96	4.13	3.35	4.35	3.78	3.48	3.22
	SD	1.07	0.92	1.19	0.78	1.13	1.31	1.13
<i>Program Design</i>	Mean	3.70	3.35	3.78	3.74			
	SD	0.97	1.30	1.20	1.18			
<i>Training and Education</i>	Mean	3.77	3.77	3.14	3.27			
	SD	1.15	0.97	1.08	0.88			
<i>Other Stake Holders' focus</i>	Mean	3.26	3.77	2.74	3.91	3.48	3.48	
	SD	1.10	0.92	1.45	1.12	1.08	0.99	
<i>Employee Involvement</i>	Mean	2.83	3.04	4.13	3.82	3.09		
	SD	1.15	0.88	0.55	1.18	1.16		
<i>Recognition and Reward</i>	Mean	2.87	2.83	2.87	3.30			
	SD	1.32	0.98	1.14	1.26			
<i>Measurements and Evaluation</i>	Mean	3.30	3.26	3.61				
	SD	1.26	1.05	0.58				
Auxiliary	Mean	4.39	3.86	2.95	2.77	2.74	3.50	3.96
	SD	0.99	1.32	1.21	1.34	1.14	1.22	1.07

Note: SD = Standard Deviation. The highest mean in each scale has also been bolded.

5.5.1 Reliability

The next step is to conduct Reliability analysis as recommended by Saraph et al. (1989).

There are two main considerations at this point, the first is the “corrected item-total correlation” and the second “Cronbach’s Alpha if item deleted”. From the corrected item-total correlations it is possible to create a matrix similar to that of Bayraktar et al. (2008) pg. 562. Their results showed that only one value (their item 4 of scale 8) was below 0.5 was considered for removal. Table 4 below shows the item to scale matrix from this research.

Table 4 Item to scale correlation matrix

Scales	Item No.						
	1	2	3	4	5	6	7
1	0.73	0.71	<u>0.24</u>	<u>0.47</u>	0.62	0.64	0.62
2	<u>0.32</u>	0.84	0.60	0.70			
3	0.79	0.58	0.63	0.56			
4	<u>0.48</u>	<u>0.47</u>	<u>0.44</u>	0.57	<u>0.35</u>	<u>0.32</u>	
5	<u>0.20</u>	0.58	<u>0.49</u>	<u>0.31</u>	0.63		
6	0.57	0.74	0.68	0.58			
7	<u>0.16</u>	<u>0.06</u>	<u>0.30</u>				

Values below 0.5 have been underlined, and values 0.5 or higher have been bolded to make them both stand out. This provides a visual way to consider which items should potentially be deleted from which scales. The first main observation is that Scale 7 has all values markedly lower than 0.5 and two of the values are below 0.2 which suggests the entire scale should be removed. Scale 4 may also be of concern as all but one item has a value below 0.5 however using the “Cronbach’s Alpha if item deleted” gives a better insight.

The observation of Saraph et al. (1989), pg. 821 is that a Cronbach’s Alpha of .700 is adequate when conducting these tests. One of the considerations is that a scale generally should have at least three items in it (Raubenheimer, 2004, pg. 60)so deleting items would need to be justified for the scales that already have a low number of items.

Each scale is presented by firstly conducting the Cronbach’s Alpha analysis with “Item Total Statistics” which shows both the “Corrected Item-Total Correlation” and “Cronbach's Alpha if Item Deleted”. “Cronbach’s Alpha if item Deleted” was used as the strong consideration for removal.

Scale 1 “Leadership and Vision”

Scale 1 “Leadership and Vision” consists of four questions from Bayraktar et al. (2008) (items 1,2,6,7) and three (items 3,4,5) added to this survey. The three added questions could have been potentially added to the Auxiliary section as items 3 and 4 dealt with “innovation”.

The initial results of examining all seven items of Scale 1 showed a Cronbach’s alpha of .819 and only item 3 was higher than that with .850 (Table 7 on page 52) which suggested the scale was acceptable as it is, but that item 3 could be removed. Table 6 shows the results of what would happen if items were removed sequentially (based on the recommendation of removing that item would increase the Cronbach’s Alpha), and the process would stop when items 3,4,5 were removed as the Cronbach’s Alpha is then .866 and the remaining four items were all lower than that.

Table 5 Reliability Statistics for Scale 1

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.819	.826	7

Table 6 Iterative process of removing items

After removing	Cronbach’s Alpha	Items for potential removal
Item 3	.850	Item 4
Item 4	.858	Item 5
Item 5	.866	none

Table 7 Item-Total Statistics for Scale 1

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Scale 1: Item 1	22.30	19.676	.725	.826	.766
Scale 1: Item 2	22.13	20.846	.710	.769	.774
Scale 1: Item 3	22.91	23.447	.242	.201	.850
Scale 1: Item 4	21.91	23.538	.468	.508	.810
Scale 1: Item 5	22.48	20.170	.615	.618	.784
Scale 1: Item 6	22.78	18.723	.637	.768	.781
Scale 1: Item 7	23.04	20.134	.619	.604	.784

Scale 2 Program Design

Program Design consists of four items with only one (Item 3) being replicated from Bayraktar, Tatoglu, and Zaim. The initial Cronbach Alpha is .794 which is acceptable, with only item 1 being higher if removed (.858). Removing item 1 and re-running the analysis shows a suggestion of removing item 2 (0.866) however after that with only 2 items remaining it would not make sense to remove either of them.

Table 8 Reliability Statistics for Scale 2

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.794	.781	4

Table 9 Item-Total Statistics for Scale 2

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Scale 2: Item 1	10.87	10.573	.317	.585	.858
Scale 2: Item 2	11.22	6.360	.835	.778	.608
Scale 2: Item 3	10.78	7.996	.599	.602	.745
Scale 2: Item 4	10.83	7.605	.700	.712	.693

Scale 3 Staff Training and Education

The first three items in this scale are replicated from Bayraktar, Tatoglu, and Zaim (2008). The Cronbach alpha is .812 and all four items were below that value for “Cronbach’s alpha if item deleted”.

Table 10 Reliability Statistics for Scale 3

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.812	.810	4

Table 11 Item-Total Statistics for Scale 3

Item-Total Statistics

	Scale Mean if Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Scale 3: Item 1	10.18	5.299	.789	.689	.680
Scale 3: Item 2	10.18	6.918	.575	.520	.789
Scale 3: Item 3	10.82	6.251	.626	.401	.768
Scale 3: Item 4	10.68	7.370	.555	.536	.799

Scale 4 Other Stakeholders' focus

This is the first scale where separate questions were worded identically with the exception that item 5 was asking the generalised “our academic institution” and item asked the specific “our CAE”. Items 1,2,3,5 are directly replicated from Bayraktar, Tatoglu, and Zaim (2008) and as noted, item 6 is a modified version.

The results for this scale are of note. Firstly the Cronbach's alpha is .701 which as Saraph et al. (1989) noted is on the border of being adequate, and secondly, the Cronbach's Alpha would lower if any of the items were removed.

Table 12 Item-Total Statistics for Scale 4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Scale 4: Item 1	17.09	12.658	.479	.647	.647
Scale 4: Item 2	16.50	13.310	.474	.561	.653
Scale 4: Item 3	17.64	11.290	.437	.730	.668
Scale 4: Item 4	16.41	11.682	.572	.529	.614
Scale 4: Item 5	16.86	13.552	.347	.326	.687
Scale 4: Item 6	16.86	14.123	.320	.485	.693

Table 13 Reliability Statistics for Scale 4

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.701	.705	6

Scale 5 Employee involvement

As with Scale 4, Scale 5 uses a pair of questions (items 3 and 4) that ask the generalised academic institution question and the specialised CAE question. Scale 5 consists of five items, of which three (item 1,2,3) from Bayraktar et al. (2008) and item 4 is the specialised version as noted. Scale 5 has 23 answers for all questions, except item 4 which has 22. This has a minor effect when considering items for removal. The interesting observation with Scale 5 is it is the first scale that had a Cronbach's Alpha below .700. This suggests that the scale is not adequate. When considering if any items should be removed, removing item 1 would get the scale to .699. Using the iterative removal approach in Scale 1, Table 6 removing item 1 and then item 4 would produce a reliability result where the Cronbach's Alpha was above .700 and no other items would increase the Cronbach's Alpha above that if there were deleted.

Table 14 Reliability Statistics for Scale 5

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.645	.695	5

Table 15 Item-Total Statistics for Scale 5

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Scale 5: Item 1	13.91	7.706	.202	.202	.699
Scale 5: Item 2	13.73	7.255	.579	.417	.529
Scale 5: Item 3	12.59	8.539	.490	.421	.597
Scale 5: Item 4	12.86	6.981	.312	.265	.646
Scale 5: Item 5	13.64	5.481	.630	.435	.454

Table 16 Iterative process for removing items

After removing	Cronbach Alpha	Items for potential removal
Item 1	.699	Item 4
Item 4	.703	None*

* Re-analysing the data after removing Item 4 showed a Cronbach's Alpha of .733. This is because item 4 had 22 responses whereas the other items had 23 responses.

Scale 6 Recognition and Reward

This scale had four items with two (items 1 and 4) mapping to Bayraktar et al. (2008). This scale is very straightforward as the Cronbach's Alpha is .814 and deleting any of the items would decrease that Cronbach's Alpha rather than increasing it.

Table 17 Reliability Statistics for Scale 6

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.814	.825	4

Table 18 Item-Total Statistics for Scale 6

Item-Total Statistics

	Scale Mean if Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Scale 6: Item 1	9.00	8.273	.573	.379	.801
Scale 6: Item 2	9.04	9.043	.740	.583	.730
Scale 6: Item 3	9.00	8.545	.682	.496	.744
Scale 6: Item 4	8.57	8.530	.582	.452	.792

Scale 7 Measurements and Evaluation

This scale consisted of three items all of which mapped to Bayraktar et al. (2008).

The Cronbach's Alpha is .295 and because there are only three items it does not make sense to remove any. Because of the very low Cronbach's Alpha, the recommendation is to remove this scale entirely.

Table 19 Reliability Statistics for Scale 7

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.295	.297	3

Item-Total Statistics

	Scale Mean if Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Scale 7: Item 1	7.70	1.130	.155	.068	.287
Scale 7: Item 2	7.35	2.146	.060	.040	.379
Scale 7: Item 3	6.87	1.391	.304	.094	-.085 ^a

a. The value is negative due to a negative average covariance among items. This violates reliability model assumptions. You may want to check item codings.

Items to be deleted

Based on both the “Corrected item-total correlation” and “Cronbach’s Alpha if Item Deleted” metrics, there are a total of eight items that should be removed from the spreadsheet and not analysed further. Table 20 shows the scale and items for removal. The items marked with * are directly mapped from Bayraktar et al. (2008) and those with ** are the modified specialised “CAE” questions.

Table 20 Items to be deleted

Scale	Item		Scale	Item
1	3		5	4**
1	4		7	1*
2	1		7	2*
5	1*		7	3*

Scale 1 item 5 as not initially removed despite it showing consideration. It would be reasonably expected that the validity testing would also show if Scale 1 item 5 should be removed. Once the reliability testing was completed, the validity testing was undertaken.

5.5.2 Validity

The validity of the instrument can be measured by using both EFA and CFA techniques. The first validity measure using EFA is to use “Maximum Likelihood” (ML) testing which was conducted on each scale individually as shown in Table 21.

Table 21 Factor analysis of each scale

Scale	# of Factors	MSA*	Total Eigen values	Items							% variance explained
				1	2	3	4	5	6	7	
1	1	.627	3.259	.917	.839	-	-	<u>.495</u>	.732	.715	56.756
2	1	.692	2.349	-	.719	.797	.954				68.741
3	1	.617	2.563	.999	.632	.561	.673				54.161
4	2**										68.343***
5	1	.693	2.073	-	.814	.681	-	.705			54.129
6	1	.749	2.628	.615	.876	.733	.718				54.970

* MSA means Measure of Sampling Adequacy.

– means this item was deleted before this analysis was conducted.

** more than 1 factor found so additional analysis required.

*** Variance explained by the two factors.

There are two main considerations from Table 21. The first is that Scale 1 item 5 has a factor loading of .495 (underlined in the table for emphasis). That item had been suggested for deletion from the reliability analysis. The second consideration is that using ML analysis on Scale 4 “Other Stakeholder’s focus” found 2 factors. Saraph et al. (1989), pg. 824 encountered the same situation with their scale “Process management”. However the initial output of the analysis in this research was not clear enough so the similar technique of Principal Component Analysis (PCA) was used that could explain the two potential factors.

Table 22 Principal Component Analysis of Scale 4

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.454	40.904	40.904	2.454	40.904	40.904
2	1.646	27.438	68.343	1.646	27.438	68.343
3	.833	13.886	82.229			
4	.617	10.276	92.505			
5	.313	5.221	97.726			
6	.136	2.274	100.000			

Extraction Method: Principal Component Analysis.

Collectively the cumulative variance explained from the two factors is 68.343% which is comparable with the other scales shown in Table 21. More importantly however is the correlations between the items and the potential factors as shown in Table 23. Of note items 1-3 have negative correlations for Factor 2, and items 4-6 have positive correlations for both factors. Items 5 and 6 however have higher correlations for factor 2 than factor 1. Examining the questions that the items relate to, items 5 and 6 are the generalised and specialised version of “Our academic institution follows up the career path of our graduates” and the “Our CAE follows up the career path of our graduates”. Item 5 is replicated from Bayraktar et al. (2008). Due to the nature of the questions, there is a reasonable argument that they form a separate factor such as “Career monitoring”. The concern as noted elsewhere is that generally factors should have at least 3 items in them, preferably more. Splitting Scale 4 into two factors would either have one factor of 4 and one of 2 (not recommended) or both of 3 (not particularly recommended either). Saraph et al. (1989) had 10 items in their scale and their component

matrix showed a clearer 6 to 4 split between their factors. It is possible the CFA approach will produce different results in this research.

Table 23 Component Matrix of Scale 4

Component Matrix^a

	Component	
	1	2
Scale 4: Item 1	.650	-.449
Scale 4: Item 2	.663	-.266
Scale 4: Item 3	.669	-.659
Scale 4: Item 4	.771	.302
Scale 4: Item 5	.535	.572
Scale 4: Item 6	.513	.722

Extraction Method: Principal Component Analysis.

a. 2 components extracted.

The next way to test the validity is to use the Confirmatory Factor Analysis (CFA) approach which uses an *a priori* approach to assigning the items to the scales. Table 24 on the next page shows the measurements for the goodness of fit and the recommended values to understand the initial CFA as shown in Table 25 also on the next page.

Table 24 Measurements and appropriate values (StatWiki, 2013)

Measurement	Recommended values
Chi Squared / Degrees of Freedom (DF)	< 3 is good, < 5 is permissible
p-value	> .05
CFI	> .95 is great, > .9 is traditional, > .8 is permissible
RMSEA	< .05 is great, < .1 is permissible, > .1 is bad

Table 25 Initial Confirmatory Factor Analysis

Scale	Number of items	Chi squared	DF	Chi squared / DF	P-value	CFI	RMSEA
1	5	12.716	5	2.54	.026	.861	.265
1*	4	5.826	2	2.91	.540	.920	.295
2	3	0	0	0	Cannot be calculated	0	.677
3	4	5.104	2	2.552	.078	.883	.266
4	6	28.168	9	3.130	.001	.478	.311
4**	4	8.742	2	4.371	.013	.755	.391
5	3	0	0	0	.000	1.000	.479
6	4	2.433	2	1.217	.296	.985	.099

* Scale 1 after item 5 removed.

** Scale 4 after item 5 and item 6 removed.

The Confirmatory Factor Analysis was conducted on each scale individually with some key observations. The first is that Scale 1 had the potential issue of item 5 being considered for deletion. The first analysis of Scale 1 in Table 25 is with the 5 remaining items, and it is not a good model based on the p value being below .05, and the RMSEA is over 0.1. As the EFA analysis showed that item 5 should be potentially deleted as well, the analysis was rerun with it removed, and the model improved as the p-value is now above .05, and the CFI is over .9. The RMSEA is still ‘bad’ however.

Scales 2 and 5 only had 3 items and the CFA analysis did not consider there to be enough information for practical analysis. With regards to scale 4, the EFA analysis suggested splitting it into two scales with items 5 and 6 in a new scale. The analysis was first conducted on Scale 4 with all 6 items. That first analysis had the first issue that the Chi Squared divided by degrees of freedom value is over 3 which is an indicator of possible concern. The p value is way too low at .001, and the CFI value is comparatively low at .478. With those values in mind, the analysis was redone with only items 1-4 in Scale 4. The results showed reasonable improvement with the p value increasing to .013 (still below the recommended .05) and the CFI increased to .755 (still below the recommended .8).

Scale 6 however showed all the attributes of a good model fit. The p-value at .296 is over the recommended .05, and the CFI is .985. Most noticeably the RMSEA is below 0.1 which is permissible, and was the only scale to have a RMSEA below .1.

Because only two scales were considered to meet the construct validity recommendations (Scales 2 and 6) it was not considered appropriate to continue with the convergent validity and discriminant validity.

5.5.3 Rejecting the CFA approach and using EFA

As the Confirmatory Factor Analysis did not confirm that the items were correctly assigned to the scales it makes sense to re-do the analysis using an Exploratory Factor Analysis approach. The analysis was conducted using all the items that had not been deleted (scale 1 item 5 had been deleted at this point), with the “Maximum Likelihood” approach. As that was not able to produce results, Principal Components Analysis (PCA) was used.

The results of that analysis showed that six components had eigentotals greater than 1 (the recommended cut-off point) and those six components accounted for 84.14% of the cumulative percentage of variance (the remaining 18 items therefore accounted for the remaining 15.86%). Table 26 on page 65 shows the “Rotated Component Matrix” after applying the Varimax rotation to the values. All values below 0.5 have been removed as they are not relevant to the component (scale) that was found. The unedited version of the table can be found as Table 37 on page 95.

Table 26 EFA Rotated Component Matrix (edited)

Rotated Component Matrix^a

	Component					
	1	2	3	4	5	6
Scale 1: Item 1	.841					
Scale 1: Item 2	.770					
Scale 1: Item 6	.738					
Scale 1: Item 7					.683	
Scale 2: Item 2			.719			
Scale 2: Item 3			.828			
Scale 2: Item 4			.896			
Scale 3: Item 1				.719		
Scale 3: Item 2				.834		
Scale 3: Item 3					.707	
Scale 3: Item 4	.706					
Scale 4: Item 1		.824				
Scale 4: Item 2	<u>.568</u>			<u>.563</u>		
Scale 4: Item 3		.694				
Scale 4: Item 4				<u>.672</u>		<u>.587</u>
Scale 4: Item 5						.826
Scale 4: Item 6						.866
Scale 5: Item 2					.844	
Scale 5: Item 3	.799					
Scale 5: Item 5	<u>.625</u>				<u>.512</u>	
Scale 6: Item 1		.812				
Scale 6: Item 2		.688				
Scale 6: Item 3		.860				
Scale 6: Item 4	.579					

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 12 iterations.

All items appear in at least one component column and the three that appear in more than one column have been manually underlined (Scale 4 item 2, Scale 4 item 4 and Scale 5 item 5). The variables have retained their original names assigned when CFA analysis was used as that is how they were laid out in the survey booklet.

The following tables (Table 27 to Table 32) consider the old scale number and item number, the survey question number, and to make the component naming easier to understand the

question text has also been included. After the tables have been presented, consideration is given to the appropriate naming of those components.

Table 27 Component 1

Scale : Item	Question #	Question text
1:1	6	Our academic institution's vision is widely known and shared by our staff
1:2	7	Our academic institution's vision effectively encourages our staff to improve the performance of our students and our institutions
1:6	11	Our academic institution's top management pursues long-term stable performance instead of short-term temporary solutions
3:4	20	Our academic institution is highly successful at recruiting and retaining high quality and experienced staff
4:2	22	Our academic institution takes into consideration the changing needs of the business world.
5:3	29	Employees are very committed to the success of our academic institution
5:5	31	Our academic institution has an organisational commitment to empower people.
6:4	35	Appointments to the administrative and academic positions across our academic institution are based on the necessary skills required by the positions.

Table 28 Component 2

Scale : Item	Question #	Question text
4:1	21	Our academic institution collects academic institution employee complaints and evaluates them carefully.
4:3	23	Our academic institution regularly conducts surveys on job satisfaction of the academic institution's employees.
6:1	32	Our academic institution has clear procedures for employee's rewards and penalties and applies them transparently.
6:2	33	Recognition and reward activities effectively stimulate employee commitment to IA efforts.
6:3	34	Recognition and reward activities effectively stimulate employee commitment to academic research in general.

Table 29 Component 3

Scale : Item	Question #	Question text
2:2	14	Due to the requirements of the CAE certification, it is easy to design new and innovative courses in Information Assurance [IA].
2:3	15	Students' requirements are thoroughly considered in the design of the IA curriculum.
2:4	16	The needs and suggestions from the business world are thoroughly considered in the design of IA curriculum and new academic programs.

Table 30 Component 4

Scale : Item	Question #	Question text
3:1	17	Our academic institution encourages education and training activities of our employees for academic excellence.
3:2	18	Our academic institution provides special training for work-related skills to all employees
4:4	24	Our academic institution has some organised efforts to understand the expectation of industry regarding our graduates.

Table 31 Component 5

Scale : Item	Question #	Question text
1:7	12	Our academic institution's top management allocates adequate resources for academic and administrative employee education and training
3:3	19	Our academic institution provides adequate financial resources for employee education and training.
5:2	28	Employees' suggestions are carefully evaluated and implemented if accepted.

Table 32 Component 6

Scale : Item	Question #	Question text
4:5	25	Our academic institution follows up the career path of our graduates.
4:6	26	Our CAE follows up the career path of our graduates.

5.5.4 Component names

Component 1 (Table 27 on page 66) is originally based on “Leadership and Vision” but has other elements relating to appropriate staffing and teamwork. Consulting the literature suggests that Mazzarol (1998) “People and Culture” or Ika et al. (2012) “Institutional Environment” while not exactly right are appropriate. For this research “People and Culture” has been selected.

Component 2 (Table 28 on page 66) is a composite of the original Scales “Recognition and Reward” and “Other stakeholders’ focus” with a focus on “employees”. It is named “Employee Recognition”.

Component 3 (Table 29 on page 67) is essentially the original Scale 2 “Program design”. As no new items were added to it, it makes sense to apply that name.

Component 4 (Table 30 on page 67) is a mix of “training” but also considers the industry expectations of the graduates.

Component 5 (Table 31 on page 67) predominantly relates to resourcing for employee training, but the old “Scale 5 item 2” relates to employee suggestions. Bayraktar et al. (2008) considered the employee suggestions to be part of “Employee involvement” and that term is considered appropriate for this component.

Component 6 (Table 32 on page 67) only has two items both which deal with the career paths of their students so “career monitoring” is a good starting point for that name.

Table 33 presents the components with their names and the source/inspiration for that name.

Table 33 Component names

Component Number	Component Name	Source/Inspiration
One	People and Culture	Mazzarol (1998)
Two	Employee Recognition	Bayraktar et al. (2008)
Three	Program Design	Bayraktar et al. (2008)
Four	Training	Many researchers have identified this as a CSF
Five	Management commitment	Derived from scale itself.
Six	Career monitoring	Derived from scale itself.

5.5.5 Additional analysis

Although not a requirement for the EFA approach, it is of course possible now to test the new factors by using the CFA approach and determine if the factors are valid due to goodness of fit modelling. Normally researchers would not likely do this, however it is considered as a relevant and interesting additional piece of analysis for this thesis. It can also suggest that the decision to put the three items that were in two different scales were put in the appropriate scale.

For CFA analysis the normal approach would be to assign items to scales (which the six components in Table 27 to Table 32 represent), conduct reliability testing (which has already been done) and then conduct the validity testing. Table 34 shows the CFA validity testing, however it has the main caveat as the earlier analysis, that components with 3 items (or less) will have potential issues with their analysis. Note “component” has been used here because it is a lot easier when dealing with the scales and items from the survey and initial CFA analysis.

Table 34 Applying CFA to the new Factors

Component	Number of items	Chi squared	DF	Chi squared / DF	P-value	CFI	RMSEA
1*	8	40.885	20	2.044	.004	.824	.218
2	5	4.910	5	0.982	.427	1.000	.000
3	3	.000	0	0	Cannot be calculated	1.000	.677
4*	3	.000	0	0	Cannot be calculated	1.000	.347
5*	3	.000	0	0	Cannot be calculated	1.000	.307
6**	2	-	-	-	-	1.000	.605

* “estimate means and intercepts” was used

** Due to there being only 2 items some of the analysis is inconsistent with the rest of the table.

Recalling the measurements in Table 24 on page 63 and the analysis in Table 25 on page 63, the analysis in Table 34 shows two main things. If “CFI” was taken as the main measurement

then yes, all the components would be “good fits” (with component 1 being “permissible” as it is greater than .800), and the Chi Squared/DF recommendations are all below 3. The RMSEA values are all well above .100 (except component 2) which is of some concern. As stated however, as four of the six components have 3 or less items assigned to them it shows that this additional analysis is more of a useful guide rather than definitive. A secondary note is that only components 2 and 3 did not have any rotated component values shared with other components (no underlined values in Table 26) so that is also likely to be a secondary effect.

Table 35 Consideration for moving items

Component	Number of items	Chi squared	DF	Chi squared / DF	P-value	CFI	RMSEA
1*	8	40.885	20	2.044	.004	.824	.218
1*	7	26.318	14	1.880	.024	.859	.218
5	3	.000	0	0	Cannot be calculated	1.000	.307
5	4	1.088	2	.544	.580	1.000	.000

* “estimate means and intercepts” was used

Table 35 considers what would happen if the old “Scale 5 item 5” was moved from the new component 1 and put in the new component 5 (this done based on numbers not question context). The calculations from Table 34 for components 1 and 5 have been included to show the difference with the new values bolded. The two key differences if the old “Scale 5 item 5” was in the new component 5 is that the goodness of fit CFI measure for component 1 improves (it cannot improve for component 5 as it was already 1.000, but it does stay the same) and component 5’s RMSEA value drops below .1 which means it has gone from “bad” to good. It also means the “p-value” for component 5 can now be calculated and is above .05 which is appropriate (component 1’s p-value also increases but not above .05). When the analysis was conducted for component 6 of including the old “Scale 4 item 4” into it, it did not solve the problems that that component had due to the low number of items associated with it.

Before moving the old “Scale 5 item 5” from the new component 1 to the new component 5 it needs to be considered contextually. The initial name for Component 1 is “People and Culture” and Component 5 is “Employee involvement”. “Scale 5 item 5” reads as “Our

academic institution has an organisational commitment to empower people”. While “Scale 5 item 5” is arguably closer to “People and Culture” it is not overly inconsistent with “Management commitment” either. It is therefore considered that the CSFs would not be harmed and also improved by moving the old “Scale 5 item 5” from Component 1 to Component 5.

5.6 Auxiliary questions

As stated in Section 4.6.3 on page 42 the auxiliary questions were primarily designed to elicit additional information about the benefits of CAE status and the views on the program of the respondents. They can also serve as pointers for follow up research. As the questions were written in the same style as those in Section 2 of the survey and also used Likert scales there is the issue that some of auxiliary questions could either be mapped to the scales and analysis could be redone (which potentially would overcome the issue of the relatively high number of deleted items) or the scales could be potentially ignored and EFA analysis conducted on all the questions from Sections 2 and 3 of the survey.

As the auxiliary questions were not designed to be a scale of their own, individual descriptive analysis makes sense here. This is reinforced with the observation that as a group the auxiliary questions had both the highest and lowest means across all questions. Question 39 (the first of the auxiliary questions) asked if the CAE status added prestige to the academic institution. This question had the highest mean of the group at 4.39 (and one of the lower standard deviations of 0.99) meaning it is reasonable to observe that those who do have CAE believe that it does have some value to their academic institution. Three other questions were then asked (41,42,43) asking if the CAE status of another academic institution was an important consideration when planning collaborative research, and if having worked or studied at an academic institution with CAE status was an important consideration when hiring a new staff member in the field of IA. The results show a declining mean (2.95, 2.77 and 2.64) respectively which suggests that while their own CAE status was of value, the respondents did not consider the CAE status of academic institution as being an important consideration in other circumstances. It is likely that there are other considerations that are more important, rather than the CAE status did not have value. Question 45 was designed to be slightly ambiguous as it was the last question before the open ended question. It asked if government encouragement was important in successfully building a CAE in IA. The ambiguity lay in what defined “encouragement” with it being potential access to direct financial support, indirect financial support or access to specialists. Encouragement could

also mean promotion by the government of the program to likely students. As the next section of analysis ‘Question 46 “The comments”’ shows, respondents did take the time to address those issues. Question 45 also had one of the higher means across the survey of 3.96 (sd of 1.07) which suggests that government encouragement as the respondent understood it is relevant to the success of building a CAE. As stated earlier, the respondent rate and margin of error are considerations for this survey, which in turn can affect the auxiliary question analysis.

5.7 Question 46 “The comments”

10 of the 23 valid responses filled in Question 46 which was worded

“If you have any closing thoughts about critical success Factors for CAEs in IA or other relevant thoughts, please feel free to include them in the box below”

Because of the broadness of the question, it can be difficult to recode the answers into something that can be meaningfully measured. The second challenge with attempting to recode the answers is that some respondents only made a single comment about one topic whereas other respondents made multiple comments about the same or different topics. Three of the answers provided were about the survey or otherwise not relevant to either CAEs or CSFs. The following are the comments received verbatim without any potentially identifying information in them. Following the comments is a consideration of the comments with respect to the criticisms of Spafford, Bishop and Taylor presented in Table 36 on page 74. Spafford’s criticisms were presented in Section 2.4.2 on page 8.

Comments

Comment 1:

'CAE in IAE is not as rigorous as it should be, but the new CAE in IA/CD is much better.

Comment 2:

'The IA field is changing and so the need for the process to reflect this is important, including recurring [sic] recertification.

Comment 3:

'My experience: it takes one or two people with vision who decide that this is going to get done. Works best from the ground up, not the top down. For us, I could point to two people who are the sole reason we got the designation, despite it ultimately being a pooling of group work.

Comment 4:

'We joined the CEA program to get access to students and research and educational funding. It has not proven worth the time or effort to do so, and we are likely to let our certification lapse. We have had no students arrive through the program, and funding has been severely limited. As a large school, it just wasn't worth the time. Many of Spaf's criticisms from this post:

https://www.cerias.purdue.edu/site/blog/post/centers_of_academic_adequacy/

Are relevant to us today. It may be a good program for small schools with little other access to funding, but it hasn't been worthwhile for us.

Comment 5:

'What are your goals? Certification alone is not particularly meaningful. When we were certified we had to show that our courses covered a wide variety of out-of-date topics. (I believe the criteria were recently updated.) To maintain certification, we must continue to map our courses to the requirements - which are neither innovative nor particularly forward-thinking. So I am not a big fan of the CAE/IAE designation. That said, the compelling reason to seek certification is that it makes our institution eligible for grant programs from the US National Science Foundation and other federal programs which provide scholarships to information assurance students. There is a LOT of money involved. So some institutions go through the motions to become certified for the grants and others disdain the certification process because their

programs are far superior to the required criteria. There is also some prestige to have this certification. However, the students at our school seem unaware of the meaning of the designation. I will close by repeating my question - what is your purpose in seeking to establish a certification program? In the US, the purpose is national security - the grant programs are intended to entice students to become expert federal IA workers.

Comment 6:

'The only reason we have a CAE designation is because it makes it easier to apply for some government funding. It is worthless otherwise.

Comment 7:

'Institutions have to walk the walk of a center of academic excellence. Whatever they did to earn the designation needs to continue after the designation has been received. One of the best things about the CAE application process is that it provides a road map on how to be a center of excellence.

Table 36 Respondent comments compared to Spafford's criticisms

Comment number	Does not measure excellence	CAE measurements not relevant or appropriate	Time and effort vs resources and rewards	Renewal process is a burden
1	<input checked="" type="checkbox"/>			
2				
3				
4		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
5		<input checked="" type="checkbox"/>		
6				
7				

Because of the wording of Spafford's criticisms and the nature of the responses, it was not appropriate to include "to gain financial benefit" as one of the fields. However comments 4 and 6 explicitly state their purpose in getting CAE status was for financial benefits either by

more students or access to more research funding, and comment 5 states that there is a lot of money involved in the CAE process.

In contrast to this, comment 3 raises an interesting insight to the CAE process, suggesting that while “leadership and vision” is a CSF, it is partly more attributable to a champion rather than group vision. Comment 7 points out that the application process makes for a good roadmap of how to get CAE status. Those are definitely important considerations if the CAE model is to be replicated overseas and that it should be an area of further research.

Overall the comments were of interest to this research, providing further insights into the respondents and their thought processes as well providing data that was suspected but not necessarily appropriate to ask with a CSF such as finances and funding which can be seen more as KPIs rather than CSFs as per Freund’s considerations (Section 3.3 on page 1410).

5.8 Summary

The analysis was conducted as per the methodology in Chapter Three. The response rate was lower than expected which in turn affected the margin of error and is likely to have affected some of the factor analysis calculations. Additionally prior research suggested that not many items were likely to be deleted but the Reliability analysis showed that at least eight items were recommended for deletion, and a ninth item was strongly considered for deletion. The CFA analysis reinforced the consideration of deleting the ninth item. Because of the deletions this in turn put the validity of the individual scales at risk, and therefore the whole instrument at risk. This in turn suggested an EFA approach should be used, which found six factors.

Those factors given appropriate names based on the literature review and are:

- People and Culture
- Employee Recognition
- Program Design
- Training
- Management commitment
- Career monitoring

The auxiliary questions with question 46 “any thoughts or comments”, while not analysed beyond descriptive statistics, did raise some interesting insights into the other elements of CSFS for CAEs. Those insights include that Spafford’s with Bishop and Taylor’s criticisms

of the CAE degree program, that financial benefit was a motivator for a number of academic institution and that many of the respondents saw the CAE program as adding prestige to their academic institution. The conclusions from this analysis are presented in the next chapter.

6 Conclusions

6.1 Introduction

This chapter presents the conclusions based on the analysis conducted in the previous chapter. Ultimately the stated goal of determining the Critical Success Factors of Centres of Academic Excellence in Information Assurance could not be satisfactorily completed using the Confirmatory Factor Analysis approach due to the unexpectedly low response rate (primarily due to the endorsement offered had not been completed by the endorser) and the unexpectedly high number of item deletions from the scales. Using the Confirmatory Factor Analysis approach showed that the a priori assignments of questions to factors from other research was not valid, but using the Exploratory Factor Analysis approach did determine there were six factors in the survey.

6.2 Critical Success Factors in Information Assurance

As shown in the previous chapter when the Confirmatory Factor Analysis was performed, only Scale 6 “Recognition and Reward” met all the validity recommendations, and Scale 1 “Leadership and Vision” (after item 5 was deleted) met two of the three main recommendations. Conversely Scale 7 “Measurements and evaluation” failed the two main analysis tests and the whole scale was recommended for deletion as not being valid or relevant using the CFA approach.

The two main reasons for this is that the initial instrument tended to have less than 6 items per scale (7-10 items per scale may have produced better results at the risk of a lower response rate), and the relatively high deletion rate of items (25%). Ideally if less items had been deleted it is potentially likely the overall instrument may have been more valid. The second reason as stated is the lower than expected response rate which in turn can affect some of the analysis. Responses in question 46 also suggested that “Leadership and Vision” was important by having one or more people being genuinely focused on creating the CAE and being able to share that vision with others, and that “Recognition and Reward”, while intended to on the individual level, it can be argued that financial reward from the government was also a critical factor.

Because the CFA approach was not satisfactory, the EFA approach was used which showed that there were six factors. Those factors were given appropriate names based on the literature review and are:

- People and Culture
- Employee Recognition
- Program Design
- Training
- Management commitment
- Career monitoring

It should be noted that “Leadership” and “Vision” which were CSFs by Bayraktar et al. (2008) were initially merged into one scale for this research and then formed the larger “People and Culture” factor.

In the context of this research “People and Culture” refers to such things as “Question 6: Our academic institution’s vision is widely known and shared by our staff”, “Question 22: Our academic institution takes into consideration the changing needs of the business world.”, and “Question 35: Appointments to the administrative and academic positions across our academic institution are based on the necessary skills required by the positions”. It means that there needs to be commitment from the academic institution itself, and senior management but also desire and motivation from the staff to ensure the academic institution wants to get the CAE status. As an additional question (39) showed one of the reasons for that is that the CAE status adds prestige.

“Employee recognition” is a subtly different factor separate from “People and Culture”. “Employee recognition” involved questions such as “Question 23: Our academic institution regularly conducts surveys on job satisfaction of the academic institution’s employees” and “Question 34: Recognition and reward activities effectively stimulate employee commitment to academic research in general”. “People and Culture” can be seen as a macro level approach by the academic institution, whereas “Employee recognition” deals more with the micro level of the employees themselves. Additionally “Employee recognition” deals with ensuring that employees are suitably satisfied with their work and are more productive.

“Program Design” is reasonably straightforward. While it is “obvious” that “program design” is critical to the success of any degree program the questions still needed to be asked. “Question 15: Students’ requirements are thoroughly considered in the design of the IA curriculum” and “Question 16: The needs and suggestions from the business world are

thoroughly considered in the design of IA curriculum and new academic programs” were two of the questions that reinforced the rationale for this to be a Critical Success Factor. There was of course the potential for both or either question to have received “strongly disagree” responses however the individual results (Table 3 on page 49) show that both questions received agree to strongly agree results.

“Training” is commonly found in Critical Success Factor research. Questions such as “Question 17: Our academic institution encourages education and training activities of our employees for academic excellence” and “Question 18: Our academic institution provides special training for work-related skills to all employees” were used to determine that training was important for the Information Assurance Centres of Academic Excellence as well. It is possible to argue that these are a part of “People and Culture” however the analysis shows that they are important on their own as a self-contained factor.

“Management commitment” could also be seen as a part of “People and Culture” however it stands apart due to “Question 19: Our academic institution provides adequate financial resources for employee education and training” and “Question 31: Our academic institution has an organisational commitment to empower people” in particular. “Management commitment” to a larger degree is the actual actions that are taken by academic institution to improve the culture.

“Career monitoring” is a term created for this factor by this author. It highlights Rockart’s observation about the subjective nature of Critical Success Factors and also why meta-analysis is a great methodology to use when there is enough research to analyse. The term is used as there were two questions that related to it “Question 25: Our academic institution follows up the career path of our graduates” and “Question 26: Our CAE follows up the career path of our graduates”. It stands out as a Critical Success Factor because it is suitably different from “Program design”. Following up on the career paths of graduates can be an important consideration in designing new courses and evaluating the appropriateness of the current courses.

Over all the factor analysis and assignment of the items (survey questions) to the new factors makes sense. The factors themselves also fit with the general idea of what would be critical to meeting certification requirements and the research adds value and knowledge by codifying those thoughts.

The auxiliary questions and question 46 in particular also presented interesting information for this research. The author's perception was that having Centre of Academic Excellence status added prestige to the academic institution of the respondent, and the survey reinforced that with a mean of 4.39 (on a Likert scale of 1-5) that had a standard deviation of 0.99. While the margin of error and response rate does have an impact on that score, it still means that prestige was something the respondents felt that the CAE gave them. Follow up questions about the CAE status of other academic institution with regards to collaborative research, and potential employment of other staff was not seen as being nearly important (means were just below 3 for those three questions).

Another conclusion that can be drawn however is the respondents' views and how they aligned with Spafford's criticisms (Section 2.4.2 on page 8). 10 of the 23 respondents completed the comments section and 7 of those were relevant to the research. Of those, 3 of the 7 made comments that were consistent with Spafford's criticisms and 3 of the 7 also made comments that potential financial reward was a strong consideration for why they undertook the CAE process.

6.3 Future work

As noted because of the lower than expected response rate from the survey one aspect of future work will be to redeploy the survey with the new factors at a time when the main endorser will be able to endorse the survey. This author and his primary supervisor believe a 40-60+% response rate can be achieved by endorsement and possibly also with enticement. Using a paper based survey while resource intensive may also produce a better response rate. It is also hoped this author will be able to present his findings at the CISSE conference in 2015 and that will allow for networking, and other types of research such as case studies which will all aid in a better response rate.

As the survey was conducted during the transition period from CAE IAE to CAE IA/CD it also makes sense to conduct research with the CAEs (either by survey or case studies) on both their experiences in the transition and if the CSFs have changed because of the transition.

The next phase for this research will be to survey the academic institutions that do not have any CAE certification to determine the reasons by using a survey instrument very similar to

the one used in this thesis. Part of the research will determine if their overall CSFs for non-CAE questions are the same as for the participants in this research, and auxiliary questions will address the reasons why they do not have CAE certification.

As Question 46 “comments” in the survey for this thesis showed an expected reason will be the resources required to gain certification, the expected resources from gaining certification and Spafford’s criticisms that resources were implied but not delivered (Spafford, 2008). This also leads to potential future work to determine how relevant Spafford’s four criticisms are these days.

Finally, as one of the initial drivers for this research was to consider what the critical success factors for creating Information Assurance courses are so they can be deployed in New Zealand and other countries, it would make sense to research what the critical success factors are for IA degree programs in other countries are and how they compare with the findings in this research.

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8 Glossary

Authentication: Authentication is a mechanism to determine the validity of a person's or entity's claim of their identity. As a straightforward example a passport is used to authenticate that a person is who they claim to be when boarding an international flight.

Availability: This refers to is the system "available" to be used. It can be seen as a measure of service reliability and metrics such as the "9s" approach is often used. As an example, the "five 9s" means the system is available at least 99.999% of the time, or in the context of a calendar year, the system is not available for 5.26 minutes for the entire year. (Wikipedia, 2014)

Centre of Academic Excellence (CAE): This is a specific designation awarded by the American National Security Agency (NSA) to academic institutions who meet requirements with regards to the appropriate teaching or research in the area of Information Assurance. The designation requires academic institutions to apply for (re)certification and demonstrate how they meet the standards.

The Colloquium for Information Systems Security Education (CISSE): The Colloquium has a stated goal connecting Academia, Business and Government to improve Information Assurance education. The Colloquium is held annually and combines the presentation of relevant research in Information Assurance with the presentation of the designation of CAE status to academic institutions.

Confidentiality: The American Department of Defense use the term "confidentiality level" in their definitions (Department of Defense, 2004):

"Confidentiality Level. Applicable to DoD information systems, the confidentiality level is primarily used to establish acceptable access factors, such as requirements for individual security clearances or background investigations, access approvals, and need-to-know determinations; interconnection controls and approvals; and acceptable methods by which users may access the system (e.g., intranet, Internet, wireless). The Department of Defense has defined three confidentiality levels: classified, sensitive, and public." (pg. 7) Underlining added for emphasis.

Essentially, confidentiality relates to ensuring that the person or entity examining the information has the appropriate permissions/approvals to do so.

Confirmatory Factor Analysis (CFA): CFA is a form of factor analysis where the research has an *a priori* model and are "Theory testing" to determine if the factor analysis "confirms" that model. (Hair et al., 2006; Matsunaga, 2010)

Exploratory Factor Analysis (EFA) (Hair et al., 2006, pg. 773):

"EFA explores the data and provides the researcher with information about how many factors are needed to represent the data. With EFA, all measured variables are related to every factor by a factor loading estimate. ...The distinctive feature of EFA is that

the factors were derived from statistical results not from theory, and so they can only be named after the factor analysis is performed”.

Matsunaga (2010) states that EFA is “Theory building” rather than “Theory testing” (pg. 98)

Factor Analysis: Hair, Black et al. (2006) describe Factor Analysis as:

“a way to condense (summarise) the information contained in a number of variables into a smaller set of new, composite dimensions or variates (factors) with a minimum loss of information” (pg. 107)

Information Assurance: The American Department of Defense describes Information Assurance as Department of Defense (2004):

“Measures that protect and defend information and information systems by ensuring their availability, integrity, authentication, confidentiality, and non-repudiation. This includes providing for the restoration of information systems by incorporating protection, detection, and reaction capabilities.” (pg. 9)

Integrity: Integrity can be seen as a measure of (the lack of) corruption in data or a system. Corrupted data may have been purposefully modified or otherwise damaged to change its true meaning and usefulness.

Non-Repudiation: Non-reputation is the process of ensuring that if a person or entity makes a claim (such as sending an email or signing a contract) then that person cannot later claim that they did not send it. This relates to authentication but has the additional steps in the process of ensuring it cannot be later challenged.

Principal Component Analysis (PCA): Matsunaga (2010) states that PCA is not a form of factor analysis as such but rather it (pg. 98):

“summarize the information available from the given set of variables and reduce it into a fewer number of components”

Other authors point out that it is closely related to Factor Analysis and have used it in certain appropriate circumstances.

Please note there are a number of statistical terms used in this thesis and the reader is highly recommended to read Hair et al. (2006) for explanations that have not been covered in this thesis elsewhere. Alternatively “Statwiki” presents the majority of the same information in “Wiki” format. Often however it is in bullet point format.

9 Appendices

Appendix A The Survey

Systems Security Education Research Project (SSERP)

Welcome to the survey. This survey is anonymous and any answers you provide will only be reported in aggregate format. The raw data will be held securely by the Department of Information Science for 3 years and then destroyed. As the survey predominantly uses close ended questions on a 5 point Likert scale and none of the questions are mandatory the survey should take less than 10 minutes of your time.

If you have any questions, comments or feedback, I can be contacted at dax.roberts@otago.ac.nz or +64 3 479 7390.

Thank you for your participation, it is greatly appreciated.

Section 1 Demographics

Q1) How is your academic institution primarily funded?

Public Private

Other please specify:

Q2) Which of the following accreditations does your academic institution have in Information Assurance?

CAE/2Y CAE/IAE CAE/R

Other please specify:

Q3) How many Centres of Excellence or similar prestigious programmes (including Information Assurance) does your academic institution have?

Q4) Approximately what percentage of your CAE IA students are from

In state _____

Out of state _____

Outside of America _____

Q5) If you wish to name your state, or academic institution please specify it here

Section 2 Factors

The following questions use a 5 point Likert scale of

1 Strongly Disagree; 2 Disagree; 3 Neutral; 4 Agree; 5 Strongly Agree

1 2 3 4 5

Please circle single most appropriate answer for each question.

Scale 1 Leadership and Vision

Q6) Our academic institution's vision is widely known and shared by our staff

1 2 3 4 5

Q7) Our academic institution's vision effectively encourages our staff to improve the performance of our students and our institutions

1 2 3 4 5

Q8) Our academic institution encourages innovation in research

1 2 3 4 5

Q9) Our academic institution encourages innovation in teaching

1 2 3 4 5

Q10) Our academic institution's top management focuses on how to improve the performance of students apart from relying on financial criteria

1 2 3 4 5

Q11) Our academic institution's top management pursues long-term stable performance instead of short-term temporary solutions

1 2 3 4 5

Q12) Our academic institution's top management allocates adequate resources for academic and administrative employee education and training

1 2 3 4 5

Scale 2 Program Design

Q13) It is easy to design courses that meet the requirements of the CAE certification.

1 2 3 4 5

Q14) Due to the requirements of the CAE certification, it is easy to design new and innovative courses in Information Assurance [IA].

1 2 3 4 5

Q15) Students' requirements are thoroughly considered in the design of the IA curriculum.

1 2 3 4 5

Q16) The needs and suggestions from the business world are thoroughly considered in the design of IA curriculum and new academic programs.

1 2 3 4 5

Scale 3 Staff Training and Education

Q17) Our academic institution encourages education and training activities of our employees for academic excellence.

1 2 3 4 5

Q18) Our academic institution provides special training for work-related skills to all employees.

1 2 3 4 5

Q19) Our academic institution provides adequate financial resources for employee education and training.

1 2 3 4 5

Q20) Our academic institution is highly successful at recruiting and retaining high quality and experienced staff.

1 2 3 4 5

Scale 4 Other Stakeholders' focus

Q21) Our academic institution collects academic institution employee complaints and evaluates them carefully.

1 2 3 4 5

Q22) Our academic institution takes into consideration the changing needs of the business world.

1 2 3 4 5

Q23) Our academic institution regularly conducts surveys on job satisfaction of the academic institution's employees.

1 2 3 4 5

Q24) Our academic institution has some organised efforts to understand the expectation of industry regarding our graduates.

1 2 3 4 5

Q25) Our academic institution follows up the career path of our graduates.

1 2 3 4 5

Q26) Our CAE follows up the career path of our graduates.

1 2 3 4 5

Scale 5 Employee involvement

Q27) Our academic institution has an established suggestion system to improve the processes by the employees.

1 2 3 4 5

Q28) Employees' suggestions are carefully evaluated and implemented if accepted.

1 2 3 4 5

Q29) Employees are very committed to the success of our academic institution.

1 2 3 4 5

Q30) Employees are very committed to the success of our CAE.

1 2 3 4 5

Q31) Our academic institution has an organisational commitment to empower people.

1 2 3 4 5

Scale 6 Recognition and Reward

Q32) Our academic institution has clear procedures for employee's rewards and penalties and applies them transparently.

1 2 3 4 5

Q33) Recognition and reward activities effectively stimulate employee commitment to IA efforts.

1 2 3 4 5

Q34) Recognition and reward activities effectively stimulate employee commitment to academic research in general.

1 2 3 4 5

Q35) Appointments to the administrative and academic positions across our academic institution are based on the necessary skills required by the positions.

1 2 3 4 5

Scale 7 Measurements and Evaluation

Q36) Our academic institution regularly audits practices according to policies and strategies.

1 2 3 4 5

Q37) Our academic institution benchmarks our academic and administrative processes with other institutions.

1 2 3 4 5

Q38) The aim of evaluation is for improvement and not for criticism.

1 2 3 4 5

Section 3 Auxiliary

The questions in this section are not necessarily Critical Success Factors but are relevant considerations for my research

Q39) CAE status adds prestige to our academic institution.

1 2 3 4 5

Q40) I believe having CAE status is an important factor for students when they consider studying at our academic institution.

1 2 3 4 5

Q41) The CAE status of another academic institution is an important consideration when planning to conduct collaborative research.

1 2 3 4 5

Q42) Having worked at an academic institution with CAE status is an important consideration when hiring a new staff member in IA.

1 2 3 4 5

Q43) Having studied at an academic institution with CAE status is an important consideration when hiring a new staff member in IA.

1 2 3 4 5

Q44) The requirements for certification are suitably difficult to ensure a level of prestige.

1 2 3 4 5

Q45) Government encouragement is important in successfully building a CAE in IA.

1 2 3 4 5

Q46) If you have any closing thoughts about Critical Success Factors for CAEs in IA or other relevant thoughts, please feel free to include them in the box below

[open box]

Thank you for taking the time to complete this survey, as stated in the opening section all data will be held securely, will remain anonymous and will only be published in aggregate form.

If you have any questions, comments or feedback, I can be contacted at dax.roberts@otago.ac.nz or +64 3 479 7390.

Appendix B The EFA Rotated Component Matrix (unedited)

Table 37 EFA rotated Component Matrix (unedited)

	Rotated Component Matrix ^a					
	Component					
	1	2	3	4	5	6
Scale 1: Item 1	.841	.249	.248	.088	.065	-.143
Scale 1: Item 2	.770	.144	.226	.262	-.009	-.430
Scale 1: Item 6	.738	.224	.122	-.237	.405	.084
Scale 1: Item 7	.447	.058	.309	.277	.683	-.306
Scale 2: Item 2	.339	.097	.719	.107	-.022	.239
Scale 2: Item 3	.177	.017	.828	.198	.330	-.103
Scale 2: Item 4	.194	-.122	.896	.213	-.025	.069
Scale 3: Item 1	.484	.141	.213	.719	.234	.009
Scale 3: Item 2	-.055	.116	.220	.834	.212	.072
Scale 3: Item 3	.161	.191	-.364	.481	.707	-.030
Scale 3: Item 4	.706	.323	.272	.150	.366	-.111
Scale 4: Item 1	.138	.824	-.359	.103	.106	.159
Scale 4: Item 2	.568	.282	.354	.563	-.091	.133
Scale 4: Item 3	.370	.694	-.138	.245	.136	.011
Scale 4: Item 4	.048	.075	.159	.672	-.130	.587
Scale 4: Item 5	-.102	.031	.132	.177	.184	.826
Scale 4: Item 6	.001	-.063	-.016	.003	-.067	.866
Scale 5: Item 2	.228	.114	.177	-.046	.844	.236
Scale 5: Item 3	.799	-.271	.049	.016	.283	.199
Scale 5: Item 5	.625	.418	.107	.186	.512	-.117
Scale 6: Item 1	-.148	.812	-.095	.073	.372	-.051
Scale 6: Item 2	.236	.688	.322	.281	.088	-.257
Scale 6: Item 3	.180	.860	.262	-.103	-.111	-.014
Scale 6: Item 4	.579	.488	.181	.377	-.156	.088

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 12 iterations.