Determining the relationship between complexity and company profitability.

By

Jaco Clarence

28242468

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Executive Summary

Businesses are becoming increasingly more complex and complexity is a fast growing problem for Industrial Engineers. According to Steven L. Schwarcz: "Complexity is the greatest challenge to 21st Century financial regulation, having the potential to impair markets and investments in several interrelated ways" (Regulating Complexity in Financial Markets 2010, p. 1). He also said that complexity can cause failures among market participants and said that these failures are driven by:" information uncertainty, misalignment of interests and incentives among market participants, and nonlinear feedback and tight coupling that result in sudden unexpected market changes" (Schwarcz 2010, p. 1). These are the same type of failures that engineers have long faced when working with complex engineering systems, therefore if complexity increases the failures will most likely also increase making engineering systems even more difficult to manage.

The Industrial Engineer is responsible to ensure a sustainable business by balancing man, machine and money through business processes however balancing these parts is proven to become more difficult as the system complexity becomes increasingly more complex. Therefore by determining the relationship between complexity and profitability of a business and obtaining a positive outcome may result in showing some of the possibilities that complexity management holds for Industrial Engineers. These possibilities includes rather shifting the focus from optimising a system when there is limiting constraints that makes optimising difficult, to managing the complexity of that system and achieving the same or better results in the process. Results such as increased profit and actually managing the complexity with the many positive results that complexity management can produce.

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1. Introduction and Background

1.1 Introduction

Complexity is a fast growing problem that places pressure on management structures, and has been established in 2008 as a property that is recognised by most managers to be harmful for their businesses. This was established by Bain&Company (Harvard Management Update August 2008) when they conducted a survey with the executives of 960 companies around the world and nearly 70 percent agreed that complexity is driving up cost and hindering growth. Complexity is the result of continual pressure for growth that businesses face in order to survive as a company in the business world. As a result of this pressure for growth companies are continuously expanding product and service lines in order to stimulate customer interest and also to gain market share. However by continuously expanding and changing the business processes to adapt for the new products and services, the complexity of a company is increased if it is not managed and monitored. Therefore complexity will most likely always grow, since companies are driven to expand their market and increase profit.

A study was done by Simplicity in order to develop a Global Simplicity Index that implies that 200 of the largest companies in the world are wasting an average of 10.2 percent of their annual profit each year due to complexity (Simplicity 2011). This is a common understanding by many that complexity affects a company's profitability: J. Marczyk stated in his book (A New Theory of Risk and Rating 2011, p. 100) that complexity has a direct impact on the profitability of a business. Where P.K Jagersma founded that: "15 to 20 percent of costs are complexity-driven, depending on the structure of the company and its industry" (Managing Business Complexity 2004). Therefore it can be of value to determine the relationship between complexity and profitability in companies and identifying the possibility it holds for Industrial Engineers.

What is complexity in a business? "Complexity is a natural property of every system. It is defined as a mix of interdependency and uncertainty" (Ontonix 2011). The interdependency consists of the links or interactions formed between activities, and the strength of that link is then measured as a function of the amount of information that flows between the respective links. Once a link's strength is established it is combined with the uncertainty in the system to create entropy. Entropy is the vulnerability of the link and the impact or chaos that can be caused by the collapse of that certain link. Therefore the system complexity is simply the sum of all the entropy. It is important to know that complexity and complication are two different things. A system may be complicated and still have a low complexity. For example a mechanical watch consists of many parts that work together in a complicated fashion to achieve the same goal however the functionality of those parts does not deliver unexpected behaviour. Therefore a system with only a few parts can be seen as a complex system but only if the parts in the system have the capacity to deliver unexpected behaviour.

It is important to realise that complexity is not all bad. It is only bad when the complexity is not managed or regulated within the company. Complexity management also holds many other positive outcomes as to increase profit such as improving the robustness, fragility and stability of a business.

1.2 Problem Statement

Businesses are becoming increasingly more complex and as a result increasingly more difficult to manage and optimise. In order to optimise a business system Industrial Engineers are required to balance the business system resources, namely man, machine and money through business processes. However with the increase of uncertainty in the system and the interdependency of the resources has proven to be increasingly difficult to manage the system as additional factors needs to be taken into consideration. Therefore by identifying the relationship between complexity and profitability, and quantifying the value of that relationship will present the value of complexity management for Industrial Engineers as an alternative tool to optimize a business.

1.3 Background on Study Scope

With the actuality of the countless and diverse companies that exist in the world, and only selecting a few companies for the study, it would be critical to choose companies that are classified in doing the same type of work or providing the same services but do not operate in a similar way or follow a similar business structure. This is to ensure that valued results are obtained that can be compared to each other and also to try and eliminate unnecessary variables that are not covered in this project scope. Therefore JSE listed companies within the IT-sector will be selected, specifically those from the Software and Computer services division. The data from these companies will then be used to determine if a relationship between complexity and profitability exists.

2. Project Aim

The aim of this project is to determine whether a relationship between profitability and complexity exists within IT companies, in order to establish the value of complexity management in the quest to increase business profit and making businesses more sustainable.

3. Project Scope

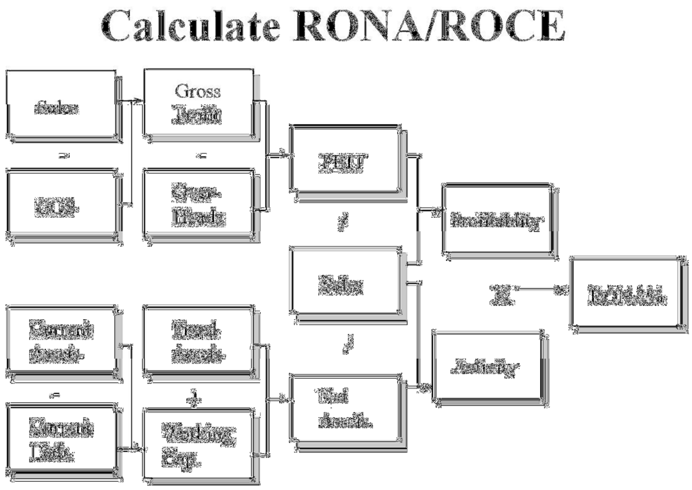
The Scope of the project can be broken down into 4 parts:

Part 1: Model for Profitability

Understanding what profitability is and how it is measured in a company is vital. Since many methods and models are available that can be used to determine a company's profit, such as ROI (Return on Investment), IRR (Internal Rate of Return), DCF (Discounted Cash Flow), ROA (Return on Assets), etc., and each having their own strengths and weaknesses. However for the purpose of this project, the profitability of the selected companies will be understood and measured by RONA% (Return on Net Assets). RONA% is a very basic and easy understandable method that is preferred by many. This method takes the assets that are used to support business activities into account rather than simply showing the robust return on sales. This allows for asset-heavy and asset-light companies to be easily comparable.

The RONA% of the selected companies will be calculated by using the audited results that is provided by McGregor BFA (McGregor BFA 2011) on the selected companies Income Statements, Balance Sheets and Cash Flow Statement. The RONA% model (Bragg 2003) will be used as a framework and will be applied to the audited information to obtain a profitability measure for each company that can be used in the correlation analysis.

Figure 1: Return on Net Assets



- Sales (Turnover) - The total amount of cash generated from operations.
- Cost of Sales (COS) - The direct cost incurred from operations.
- Overheads – The indirect cost incurred from operations.
- Profit before Interest and Taxes (PBIT) – Profit before interest and tax are added/subtracted.
- Current Assets – Short term assets that is used to fund day to day operations.
- Current Liabilities – Is the company’ debt and obligations that are currently due.
- Fixed Assets – Property, plant and equipment.

Part 2: Complexity Analysis Instrument

Complexity is a natural property of every system; it is a mix of interdependency and uncertainty that is believed to have an impact on business profitability. The complexity analysis instrument that is going to be used for the measurement of complexity is called OntoSpace (Ontonix 2011). This tool measures the correlation and mutual information between activities as well as the strength of that correlation and combines it with the uncertainty in the system to create entropy in order to calculate the complexity.

The Complexity Analysis Instrument provides various measurements that can be used for a complexity analysis, however for this project only the following will be used:

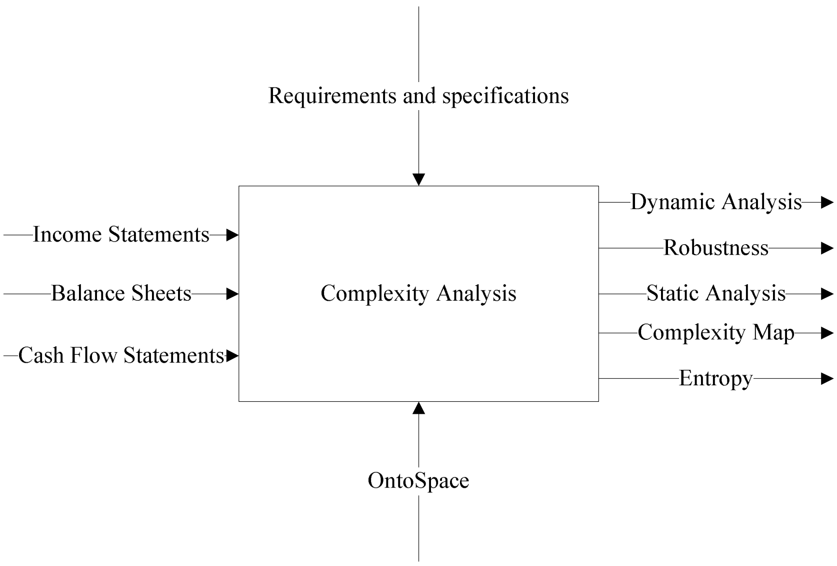
a) Complexity Map (Static analysis)
b) Dynamic Analysis (Shows the change in complexity over time)

c) Complexity Measures
d) Entropy map
e) Complexity Rating

Part 3: Analysis of IT Sector:

In part 3 a complexity analysis will be completed with the use of OntoSpace. The inputs or data for the complexity analysis instrument will be obtained from the Income Statements, Balance Sheets and Cash flow Statements of the selected companies. However the input data must first undergo a data cleaning process so that it is in usable format and according to specification for the instrument. Another important aspect required from the data cleaning process is to consolidate the different attributes of the companies, to create a generalized income, balance and cash flow sheet to ensure the result obtained from the complexity analysis tool is accurate and comparable. The outputs/results from the complexity analysis instrument will then be used and combined to create a State of Health profile for each company and is to be used in the correlation analysis. Individual analysis will also be performed to get a better understanding of the complexity growth and how it affected each company individually over time.

Figure 2: Complexity Analysis Inputs and outputs



Part 4: Correlation between Complexity and Profitability

The goal of part 4 is to determine if a relationship exists between complexity and profitability by using the results obtained from the profitability model (Part 1) and complexity analysis instrument (Part 3). The type (linear or non-linear) and strength of the correlation will also be determined to obtain insight on the relationship which can be used and exploited by the IE since relationships indicate a predictive power over the variables in correlation. If a relationship between complexity and profitability does exist the value of complexity management will be weighed against other IE optimization techniques that are used to increase profit.

4. Literature Review

A literature review was done on all relevant aspects, tools and methods to be used in the research project in order to obtain a thorough understanding on what needs to be done and what approach to follow.

4.1 Complexity Management

4.1.1 Introduction

Companies all over the world are struggling with complexity and most of these companies don't even realise that it is a crisis of their own doing (Mariotti 2009, p. xi). This complexity crisis is crippling companies, destroying company profit and draining resources, and most companies still don't fully understand the impact of this complexity crisis and nor do they know what to do about it.

Let's look at a simple example used by J.L Mariotti. Take a simple coffee mug and assume that it is your only product. If your product has one style, colour, size, package in one style, sourced from one supplier, packaged and stored in one location, it will enable you to accurately calculate the standard cost per mug in terms of material, labour and overheads. It is only natural for businesses to proliferate products in order to keep customers happy. So what happens if you expand your product (mug) line to 4 styles, 8 colours, 2 sizes, and 6 package variations sourced from a total of 5 suppliers and packaged at 2 distribution points?

There are now at least 384 (4*8*2*6) mug SKU's (Stock-keeping unit/code) to be stocked in 2 locations (Mariotti 2009, p. 48-49) This example shows how easy and explosive complexity can be introduced into a system. Showing how this increase in complexity can easily be overlooked when you introduce proliferation on products to expand your market for growth alone and not considering all the factors.

There are only a few parts of a business that are so underestimated and poorly measured as complexity (Mariotti 2009, p 65).

4.1.2 Why Complexity Management

Complexity in businesses is rapidly increasing and it is becoming increasingly more difficult for Industrial Engineers to create sustainable business systems alongside complexity. According to J.L Mariotti (The Complexity Crisis 2008, p. xiv), the rapid increase of complexity originates from companies that hunt for double-digit growth in markets that are only growing at a low single digit rate and that this increase in complexity is driven by the proliferation of products, customers, markets, suppliers, services, locations, and many more. J.L Mariotti also said that this rampant proliferation adds to cost in a manner that goes untracked by even the best modern accounting systems and that complexity from proliferation needs to be recognized as a potential profit drainer, and managed as the critical business consideration it has become (Mariotti 2008, p. xiv).

Complexity is believed to have three major impacts on a company namely fragility, profit and responsiveness to change. The fragility of a business is measured through a basic formula: Fragility = Complexity of the business system * Uncertainty of the environment in which the system operates in, for example the turbulent economy (Marczyk 2011, p. 28). When a business system becomes fragile it also becomes vulnerable and as a result becomes less sustainable. As mentioned before, Industrial Engineers are responsible to balance man, machine and money through business processes to create a sustainable business system, however if complexity is linked to fragility, which directly affects the sustainability of a system, it would make the sustainable effort created by the Industrial Engineer somewhat meaningless if the system is highly complex. This leaves us with the question of what is the best approach Industrial Engineers should follow in the quest to make a business competitive (profitable), what optimisation method or tool to consider.

Profit is believed to have a relationship with complexity in the sense that highly complex systems are less profitable than lower complex systems. This relationship or impact of complexity on profit is the belief of J. Marczyk (A New Theory of Risk and Rating 2011, p. 100), J.L Mariotti (The Complexity Crisis 2008), P.K Jagersma (Managing Business Complexity 2004), and many more. Also companies such as Bain&Company (Harvard Management Update August 2008) and Simplicity (Simplicity 2011) have conducted studies and surveys and came to the same conclusion. Although the type of relationship differentiates between the professionals and companies, they all agree that complexity has some kind of impact on profit. Therefore if the value of complexity management can be quantified with profit, it will create an opportunity to weigh its value against other optimisation tools and methods.

Another important aspect that can be affected by complexity is the responsiveness of a business system to change. System responsiveness to change or robustness is the ability of the system to absorb both expected and unexpected variation of operational conditions, without failing or compromising the function of the system. This means that the robustness says nothing on the performance of a system but actually the system ability or strength to keep his performance at its current level (Marczyk 2011, p. 70).

4.1.3 Industrial Engineers are affected by Complexity

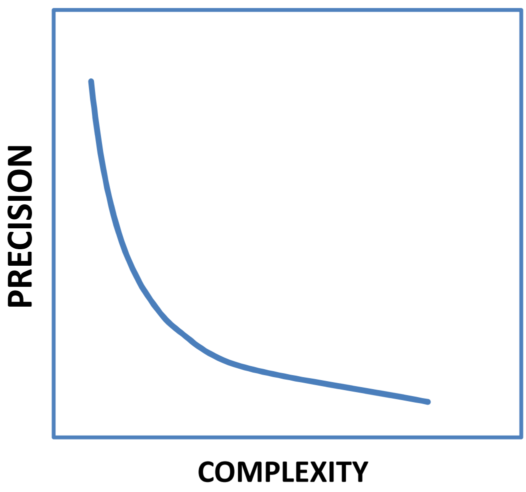
Optimisation is a word that is commonly used by engineers; they are trained to optimize systems by spending countless hours trying to find the best products to implement in the system for an optimal solution. But what happens if complexity is affecting the products, making them less effective, less identifiable or even unproductive?

Steven L. Schwarcz said that complexity can cause information uncertainty, nonlinear feedback and tight coupling, misalignment of interests and incentives in a business. These are the same type of failures that engineers have long faced when working with complex systems (Regulating Complexity in Financial Markets 2010, p. 1).

When a system is highly complex it implies that many tight couplings exists within the system, meaning that various parts in the system are interconnected with strong relationships and as a result when a change is implemented into the system more and more parts will be affected by that single change. Therefore more factors needs to be taken into consideration before change can be implemented into the system. Even if all the information from the complex system is disclosed, the amount of information that needs to be analysed still increases as complexity increases and as a result the value of the change becomes a more complicated task to calculate. This will ultimately make optimisation of a system to its constraints an increasingly complex task as complexity increases.

As complexity increases the uncertainty of the tight couplings within a system also increases, ultimately to a point where the uncertainty simply becomes too difficult to manage since the behaviour of the system becomes highly unpredictable when new management products or change is introduced. A fundamental philosophical principle that sustains this concept is L. Zadeh's Principle of Incompatibility: High complexity is incompatible with high precision (Zadeh 1969).

Figure 3: Principle of Incompatibility



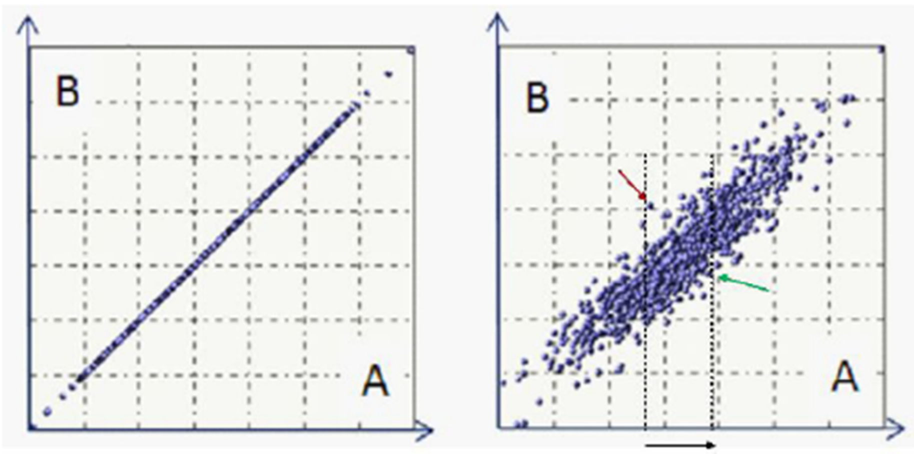
Implying that the more complex something becomes, the less precise we can be about the behaviour of that complex item. Therefore if precision decreases our ability to predict or measure the value of optimisation products will also decrease, to a point where management is based on guess work and not on facts, making the business system increasingly fragile and at the end of the day less sustainable.

4.2.1 What is Complexity and how is Complexity measured

It is a common understanding that something cannot be managed or understood if it cannot be measured.

Complexity is recognised as a property that exits in every system and is defined as a mix of structure (interdependency) and uncertainty (Ontonix 2011). The interdependency part is measured by calculating the generalised correlation and mutual information between activities, where correlation is a statistical measure that refers to the relationship between two random variables and mutual information represents the strength of that correlation. Variables with high mutual information show a strong relationship and a variable with zero mutual information shows uncorrelated variables. By combining the strength of the relationship between variables and the uncertainty of those variables will create entropy, the ability to create chaos. Therefore a relationship with high entropy is more important to a user than a relationship with low entropy.

Figure 4: Crisp and fuzzy rule example



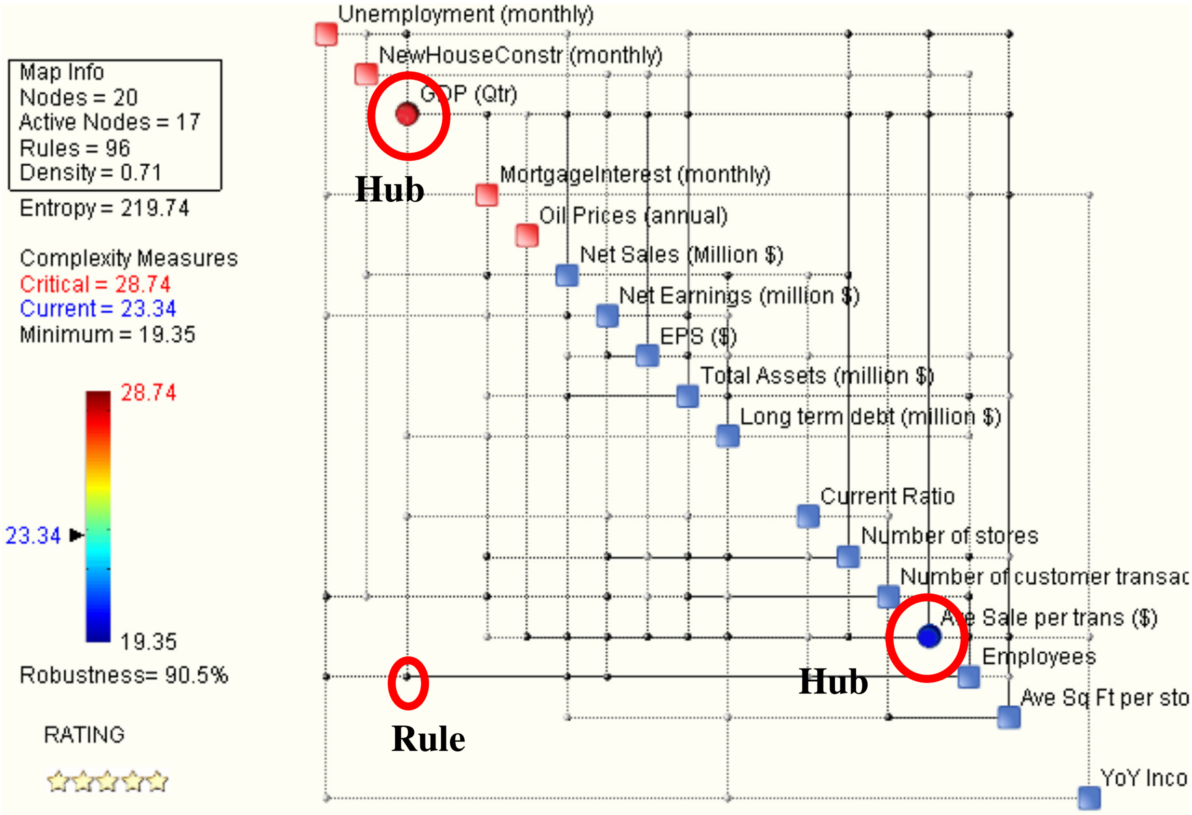
A fundamental component of the complexity measure is therefore entropy, the degree of disorder in the system and the amount of information flow between two points in the system. Another explanation for entropy can also be seen as the degree of rule fuzziness and the amount of information a given rule transmits. Figure 4 illustrates the crisp rule on the left and the fuzzy rule on the right. A crisp rule for example is: “if A then B”, meaning that if A is a certain value then B will always be a specific corresponding value. This suggests that the crisp rule can be seen as a linear equation (y = 2x+1) where the input value will always give the same output value. Where an example of a fuzzy rule may be: “if it rains the accidents on the roads will increase”, meaning that when event A increases or decreases it doesn’t necessarily lead to an increase or decrease in event B. For instance look at the fuzzy rule graph on the right: if A has a certain value (red arrow), then the increase in A is equivalent to length of the black horizontal arrow, meaning B can take on any value in the dotted column, as indicated by a green arrow. Once the rules are established based on actual measurements will allow for a map to be easily drawn. The map defines the structure of the system and the entropy of the rules contributes to the fundamental component of uncertainty that is necessary to measure complexity in the system.

To fully measure complexity in a system, structure (rules), uncertainty (entropy) as well as two additional pieces of information, namely coarse-graining and granularity are required. Coarse-graining is the type and number of variables chosen to describe the system and Granularity is the degree of precision one employs to measure the state-vector components, meaning how precisely each parameter is measured in terms of number values with significant digits.

4.2.1 OntoSpace the Complexity Analysis tool

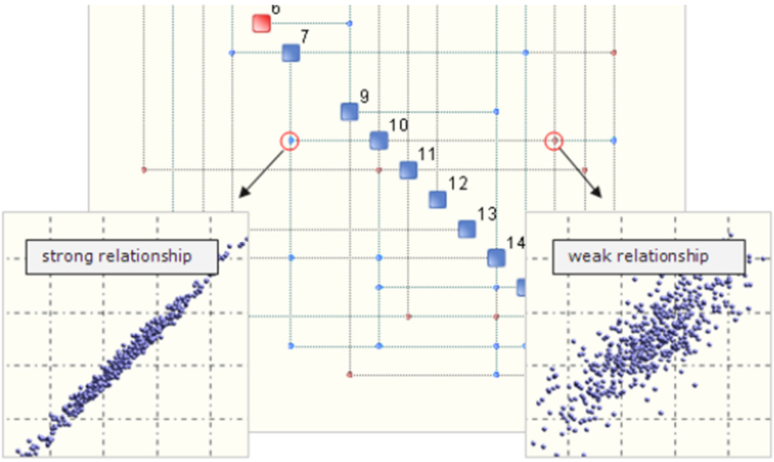
The OntoSpace tool that is used for the complexity analysis provides various complexity and complexity related measures and some of these measures are discussed to obtain background knowledge for the understanding of the results. Figure 5 shows an example of a system map with some of the corresponding measurements related to that map.

Figure 5: System Map Example



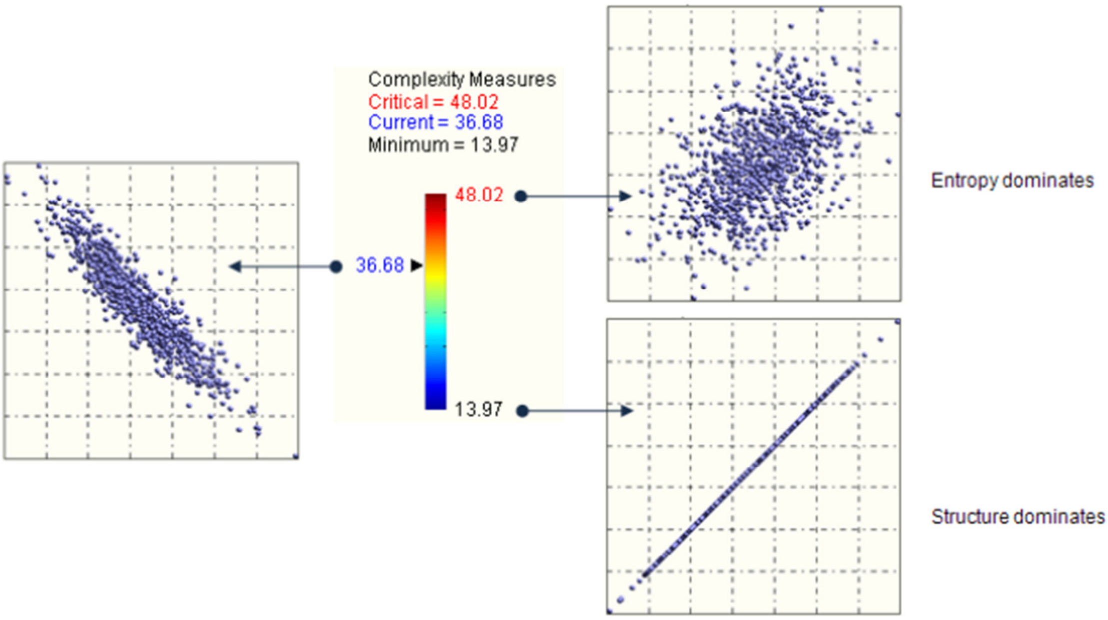
- *Nodes* is the amount of data variables in the analysis
- *Active Nodes* is the amount of active data variables show on the map
- *Rules* are the amount of relationships (links) or information flow that exists between Nodes and is also illustrated on the map as grey and black connections. The black links represent strong relationship and the grey link weak relationships. See Figure 6.
- A *Hub* is the most interrelated variable in the system and a loss of a *Hub* in a given system may seriously damage the system.
- The map Density is calculated by D = 2*(L/(N(N-1))), where L is the number of significant links and N the number of active nodes. For example take the values from Figure 5, D = 2*(96/17(17-1)) = 2*(96/272) = 70.58. This measure shows how complicated the system is and how interrelated the variables are with each other. It shows how difficult it would be to introduce change in the system, as a change at any Node would immediately propagate to numerous other nodes.

Figure 6: Example of a Strong and Weak Relationship



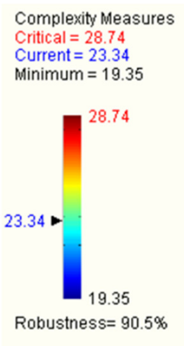
- *Entropy* is the amount of structured information that flows between Nodes in the system.

Figure 7: Example of Structure and Entropy dominant



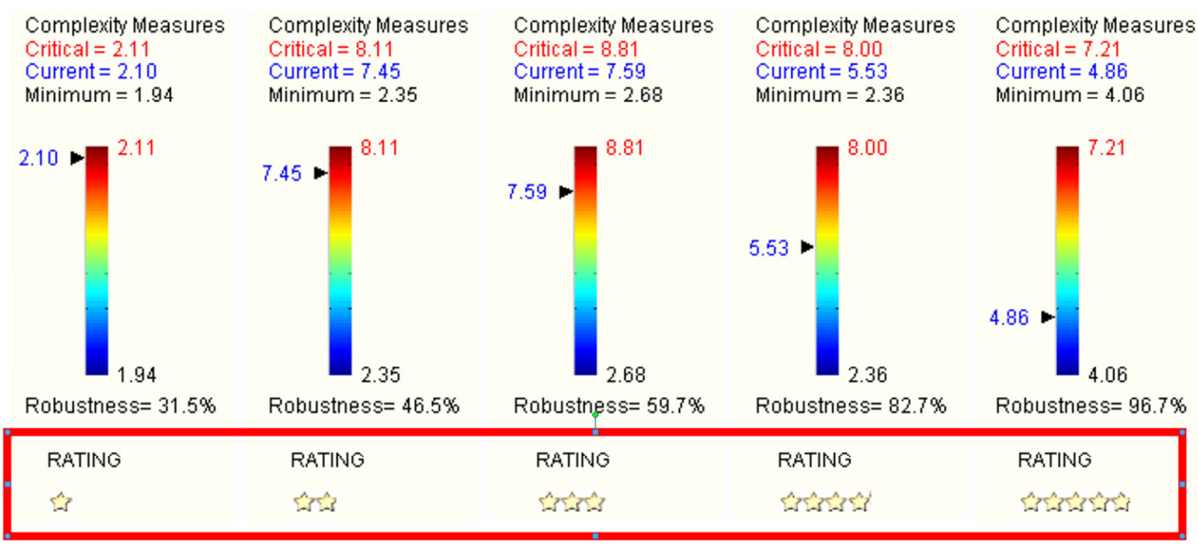
- The *Robustness* measure is the resilience of the topology of the information flow within the system. It is a function of the current complexity of the system map and the corresponding minimum and maximum complexities that can be seen as the upper and lower bound of the system map complexity. The maximum complexity, also known as the critical complexity, is the point where the adding of a small increment of entropy to the system, will ultimately or partly destroy the structure of the map. It is said that the system behaves in stochastic fashion at critical complexity while moving to a more deterministic fashion when the system moves closer to the minimum complexity, See Figure 7 and 8.

Figure 8: Example of Robustness Measure



- The complexity *Rating* is divided into five groups and is illustrated by a star rating ranging from one to five. Where the one star rating is when the system is close to its critical complexity and where the structure will start falling apart, and a five star rating is when the complexity is very low and indicates that the system structure is strong, highly sustainable, manageable, efficient, etc. An example of the star ratings is show in Figure 9.

Figure 9: Example of Complexity Ratings



The following is an interpretation of the complexity ratings (Ontonix 2011).

☆ Business complexity is very high. Close to its critical complexity. Its Structure is weak. The business is unsustainable and very fragile. Exposure is very high and the business is highly inefficient and very difficult to manage. It is impossible to make forecasts and define realistic goals.

☆☆ Business complexity is high. The business is highly complex and difficult to manage and control. Exposure is high as well as inefficiency. The structure of the business is fragile hence vulnerable. It is difficult to make forecasts.

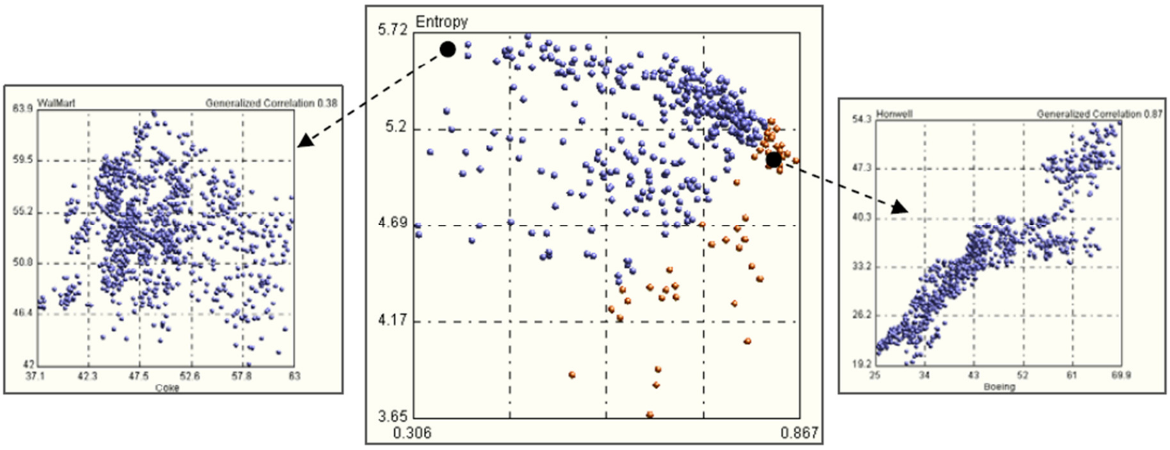
☆☆☆ Business complexity is medium. The structure of the business is fairly robust. Performance predictability is acceptable. Exposure is moderate.

☆☆☆☆ Business complexity is low. This indicates a robust business structure. Predictability is high, exposure is low. Business sustainability and efficiency are quite high.

☆☆☆☆☆ Business complexity is very low. This business structure is very strong. Exposure is very low. The business is manageable and it is possible to make credible forecasts. The business is potentially highly sustainable and efficient.

- The Quick view or anthill plot shows the amount of information exchange that exists between two variables, see Figure 10. Exchanged information is also known as mutual entropy or in more familiar terms, statistical correlation. In Figure 10, 2 coloured dots are visible. The blue dot represents variables that exchange little information and can be regarded as irrelevant, where the orange dots represent variables with more structured information and corresponds to a high generalized correlation.

Figure 10: Example of a Quick View



Dynamic Analysis

Figure 11: Example on how the Dynamic Analysis work

Step 1

Step 2

Step 3

Variable 1	Variable 2	Variable 3	Variable 4	Variable 5
90.37195303	64.85701237	46.87428332	85.79767729	67.60499329
35.27261485	83.28417754	45.30508919	86.51987701	74.73590809
54.64585535	33.94933818	62.93814659	84.65528442	57.96700254
20.54019984	81.50074035	48.51241897	78.76213017	1.40110652
69.08003382	9.294449131	43.34918603	93.02122625	24.55135337
43.04269247	31.38272235	64.05936327	42.30921404	73.55581661
3.917181175	57.63488772	89.71602963	66.77621254	34.55787244
39.76387452	75.4905255	38.6897269	98.10226704	7.986475194
25.74216227	57.05564204	57.86304483	86.09726662	88.59200938
48.15115611	79.88739031	49.76186992	81.6186695	65.61031814
41.36531277	22.52706471	23.32495845	38.75146857	20.41274998
54.64977613	99.90398563	35.95973985	80.97317874	79.4028892
34.55068785	6.42353161	43.80101237	28.51400698	68.85538848
26.65810873	36.66687172	31.57521941	33.36941578	30.55341679
49.79364939	41.94217485	62.89313374	81.7089161	25.43827296
23.41225678	23.22056299	3.397128474	52.1913204	26.24639998
99.19328964	63.63506628	32.7776316	46.66077517	21.25773548

Window size

Overlap

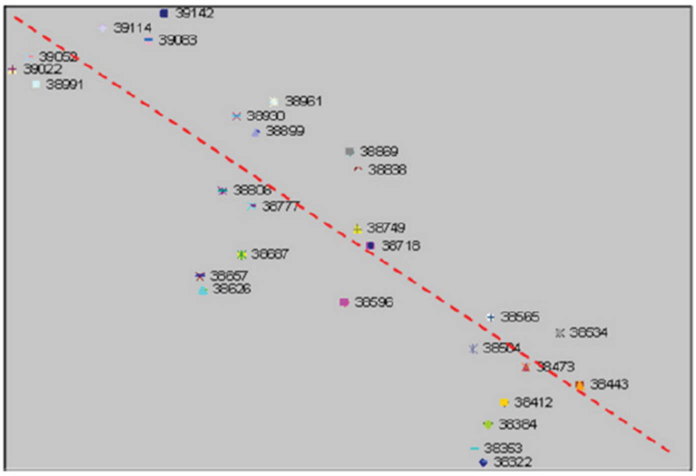
OntoSpace allows for time-dependent as well as time-invariant data analysis. The dynamic analysis is a time-dependent analysis and works the same as a moving average that is used in statistics, and return results in steps. Steps represent results at a specific time in the studied period and the number of steps depends on the amount of samples, window size and overlap size. Figure 11 is an example of how OntoSpace used data for a dynamic analysis, with a window size of 10 and overlap of 7 as input values.

4.3 Past Studies

Complexity hurts business performance and as n result profitability. Adrián A. Caldart and Fernando Oliveira investigated how competitive complexity can affect an industrial sector profitability by developing a set of simulations (model) that represents industries as complex systems. Showing how the increase in complexity can damage performance that leads to the loss of profitability (European Management Journal (2010) 28, 95-107).

According to J. Marczyk complexity has a direct impact on the profitability of a business (A New Theory of Risk and Rating 2011, p. 100). This statement was made on the results from a study that was done on 28 new branches of a single bank that opened in the same year. In this study the complexity and profitability of each branch was calculated and plotted to see the relationship between complexity (horizontal axis) and profitability (vertical axis).

Figure 12: Study on complexity and profitability

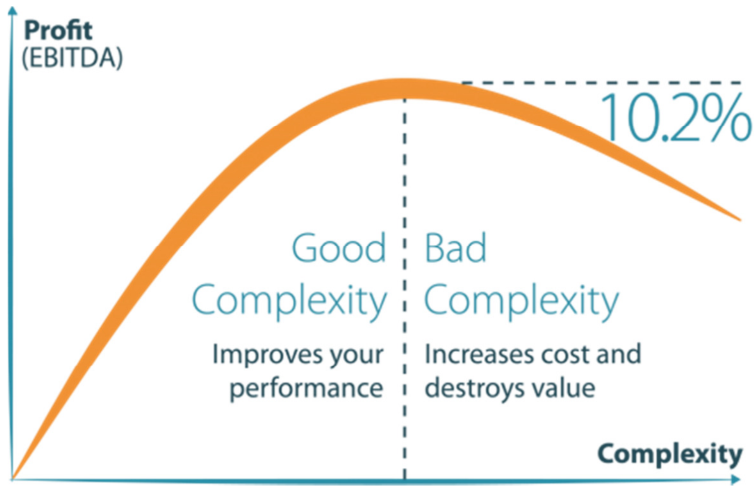


(A New Theory of Risk and Rating 2011, p. 100)

Bain & Company has done a survey on executives at 960 companies around the world, nearly 70% indicated that complexity was driving up costs and hindering growth (Gottfredson and Schwedel 2008, p. 3).

Simplicity found that bad complexity reduces the profits (EBITDA) of the Fortune Global 200 Companies by 10.2% on average. Their conclusions and insights were drawn from two primary research programs, The Global Simplicity Index and The Complexity Management Survey. The Global Simplicity Index is a statistical model of business complexity developed by S. Collinson a professor of International Business and Innovation at Warwick Business School. This model covers 18 drivers of complexity and business performance. Where The Complexity Management Survey is based on a structured survey involving over 500 manager and leaders working in companies with 10,000+ employees across Europe (Simplicity 2011, p. 5).

Figure 13: Good vs. Bad Complexity



(Simplicity 2011, p. 7)

Simplicity concluded that there are two kinds of complexity, namely good and bad complexity. See Figure 11. Good complexity, which they believe is necessary for a company in order to grow and improve performance and Bad complexity which is the point where complexity increases unnecessary cost and destroys value.

5. Strategy

5.1 Identified Companies

The first and fundamental step required before analysis can begin, is to identify valid JSE listed companies within the IT sector for this study. This requires the companies to have enough data points to obtain accurate results for the complexity analysis tool. Eight companies were identified which started before the year 2000 and therefore can deliver enough data points for the analysis. These companies are Datacentrix Holdings Limited (DCT), Datatec Limited (DTC), EOH Holdings Ltd (EOH), Gijima Group Ltd (GIJ), Securedata Holdings Limited (SHD), UCS Group Limited (UCS), Adaptit Holdings Ltd (ADI) and Paracon Holdings Limited (SDH).

5.2 Development of Input Sheets

Each individual company's data was sourced from McGregor BFA and the same format was used as provided by McGregor BFA to create the input sheets for the Ontospace tool. However the attributes that differed or were missing and incomplete, was sourced from the individual companies' published and audited results. This was to ensure that the Income Statement, Balance Sheet, and Cash flow Statement of all the companies contained the same attributes and were as complete as possible to ensure accurate and valued results obtained. After the sheets have been created, they were modified according to the specification that is necessary for the Onotspace tool, which is used for the complexity analysis.

5.3 RONA Calculation

The data that was sourced from McGregor BFA was also used in the calculation of the selected companies' return on net assets (RONA%). Where RONA% results reflected discrepancies, the data was also consolidated with the published statements where necessary. This is to ensure that an accurate understanding of each company's RONA% is established.

6. Data Analysis

Data analysis is an important step that is vital for the interpretation of results. This includes inspecting, cleaning, transforming and modelling of the data with a goal to highlight information that is useful and gives an insight on the purpose of the study. Therefore an analysis was done on individual companies as well as a consolidated analysis between the companies to obtain a local and global understanding on the results.

6.1 Consolidated Analysis

Static analysis was performed on each company in order to compare the results with the respective companies in the quest to establish the relationship between complexity and profitability. The results from the static analysis, see Appendix A, were used to create summary profiles on each company complexity rating and related complexity measures in order to get background knowledge on the company complexity measures.

Figure 14: DCT Complexity Measure

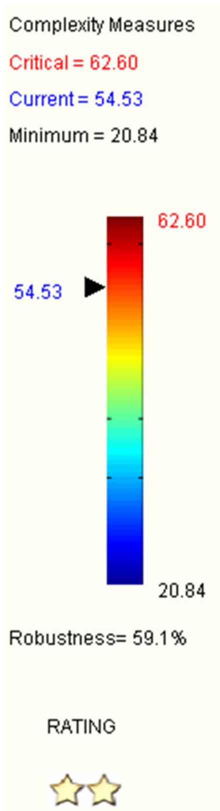


Figure 15: DTC Complexity Measure

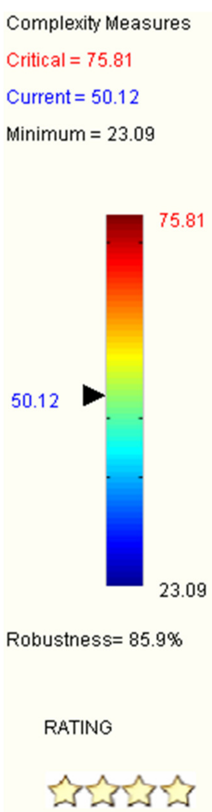


Figure 16: EOH Complexity Measure

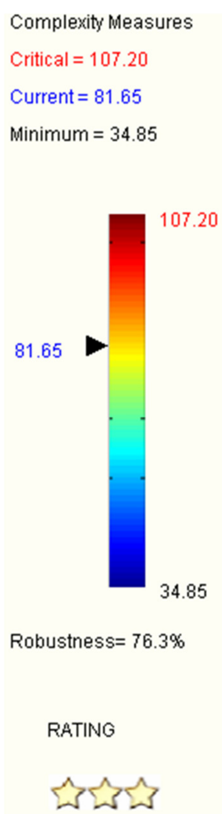


Figure 17: GIJ Complexity Measure

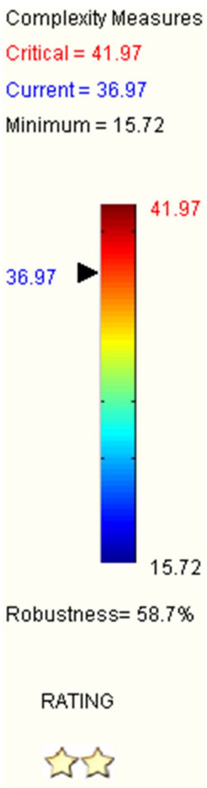


Figure 18: SDH Complexity Measure

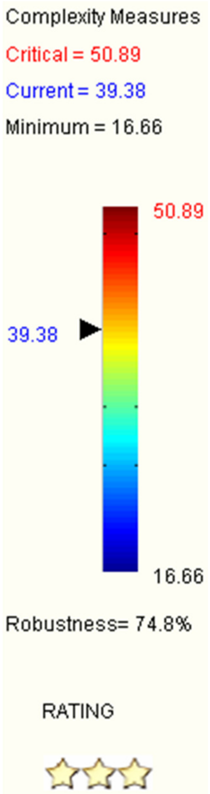


Figure 19: UCS Complexity Measure

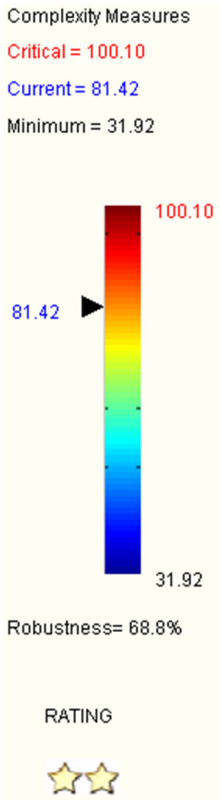


Figure 20: ADI Complexity Measure

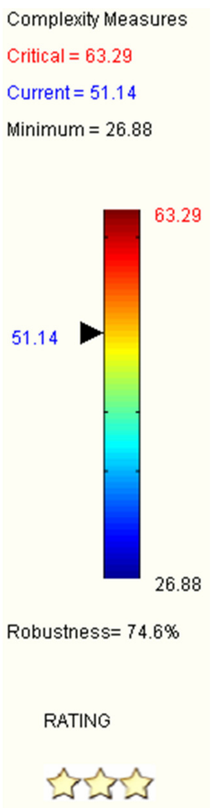
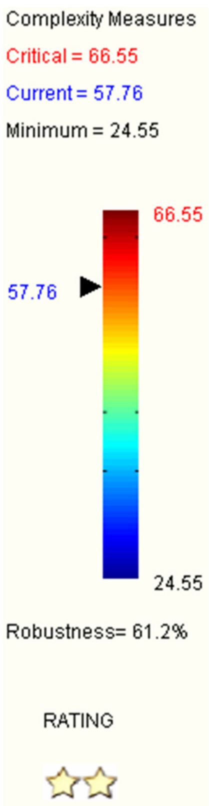
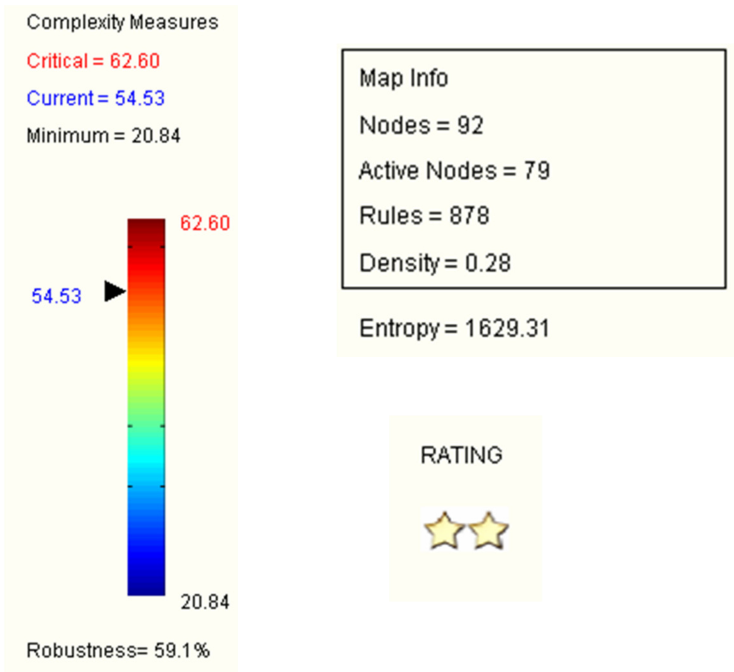


Figure 21: PCN Complexity Measure



6.1.1 Datacentrix (DCT) Static Profile

The density of the complexity map is < 0.50 which indicates a low interdependency between measured items. This implies that change will be easily introduced in the system.



The Rating shows that the business is highly complex and difficult to manage and control. Exposure is high as well as inefficiency. The structure of the business is fragile hence vulnerable. It is difficult to make forecasts.

Figure 22: Set Contribution to Total Complexity of DCT

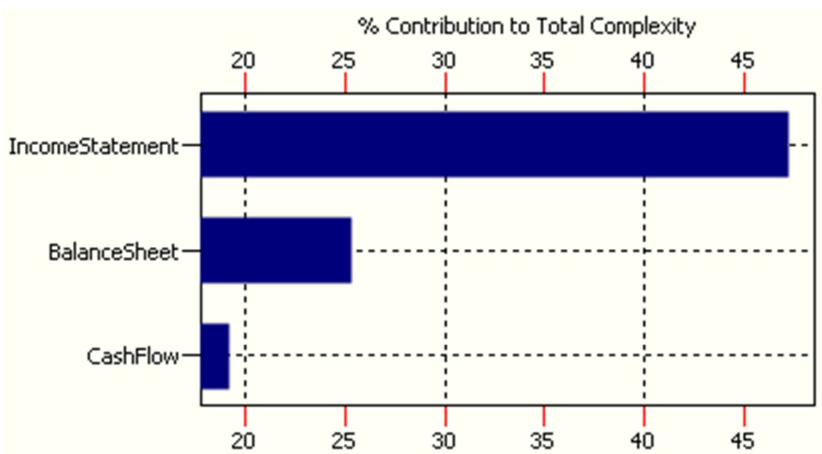


Figure 22 shows the set contribution to the total complexity whereas Figure 23 shows the top 5 complexity contributions of the system total complexity.

Figure 23: Top 5 Complexity Contributions of DCT

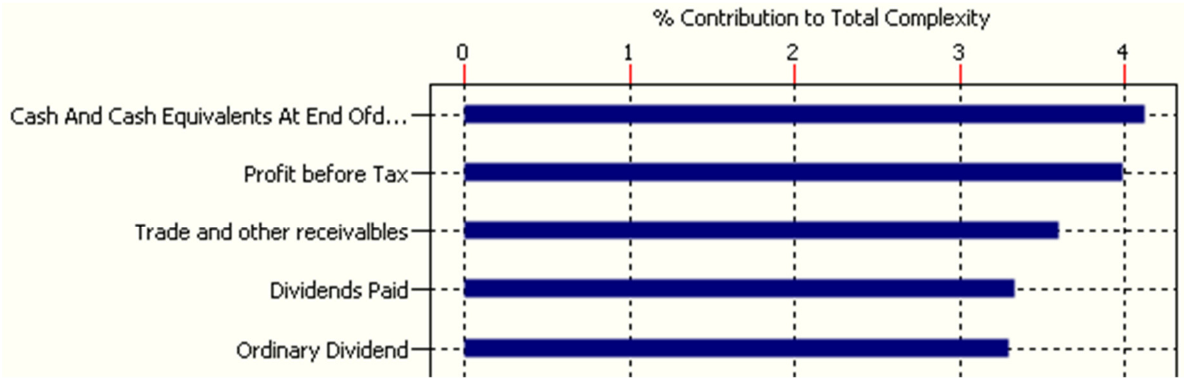
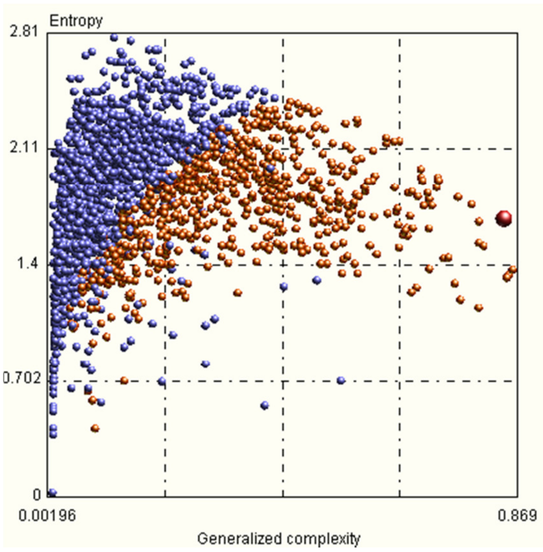


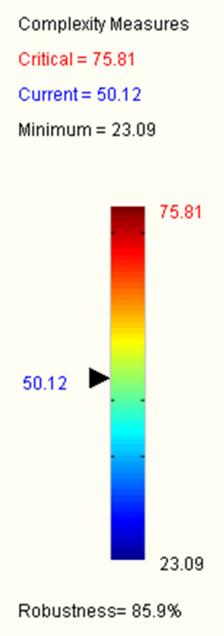
Figure 24: DCT Quick view (Entropy view)

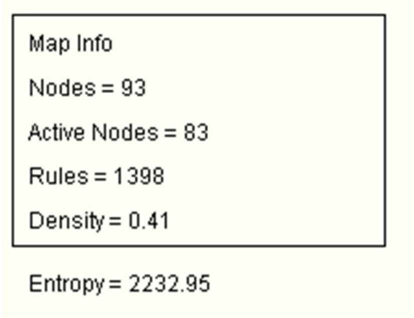


The Entropy view shows the concentration (summary) of all the generalised correlation values between the variables.

6.1.2 Datatec (DTC) Static profile

The density of the complexity map is < 0.50 which indicates a low interdependency between measured items. This implies that change will be easily introduced in the system.





The Rating shows that business complexity is low. This indicates a robust business structure. Predictability is high, exposure is low. Business sustainability and efficiency are quite high.

Figure 25: Set Contribution to Total Complexity of DTC

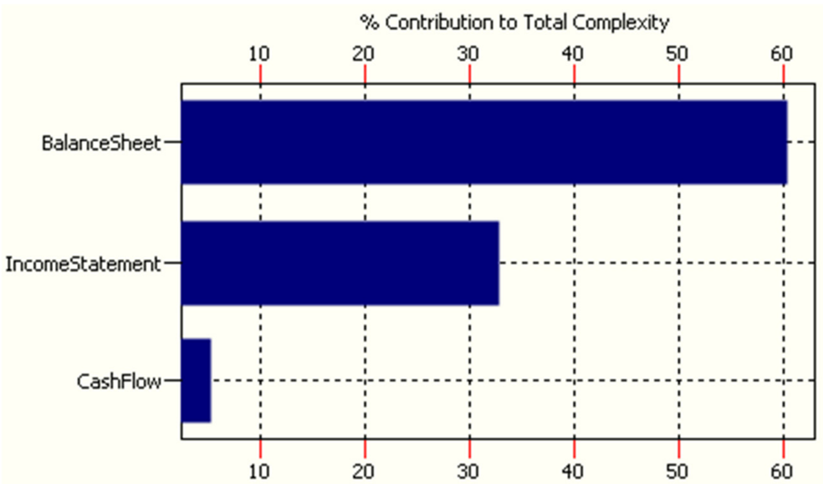


Figure 25 shows the set contribution to the total complexity whereas Figure 26 shows the top 5 complexity contributions of the system total complexity.

Figure 26: Top 5 Complexity Contributions of DTC

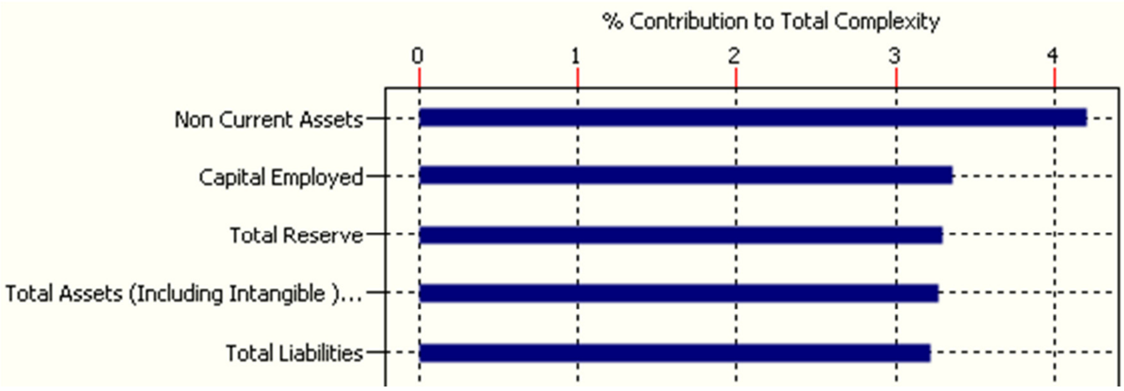
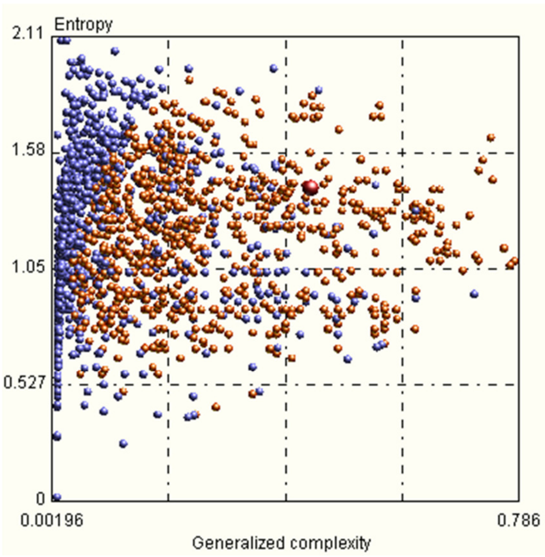


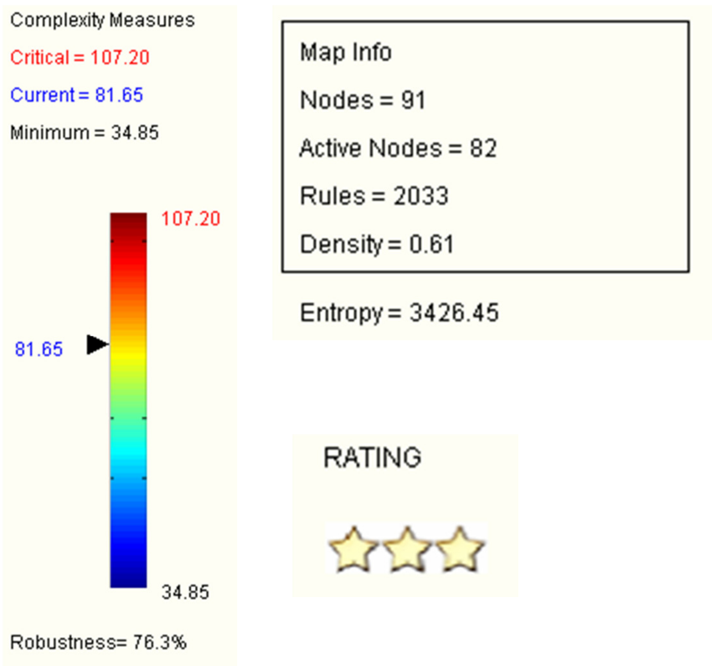
Figure 27: DTC Quick view (Entropy view)



The Entropy view shows the concentration (summary) of all the generalised correlation values between the variables.

6.1.3 EOH (EOH) Static Profile

The density of the complexity map is > 0.50 which indicates a high interdependency between measured items. This implies that change will be difficultly introduced in the system.



Business complexity is medium. The structure of the business is fairly robust. Performance predictability is acceptable. Exposure is moderate.

Figure 28: Set Contribution to Total Complexity of EOH

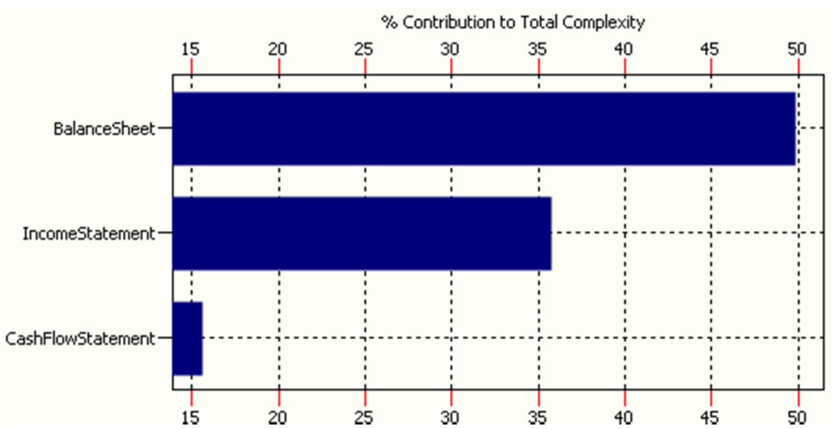


Figure 28 shows the set contribution to the total complexity whereas Figure 29 shows the top 5 complexity contributions of the system total complexity.

Figure 29: Top 5 Complexity Contributions of EOH

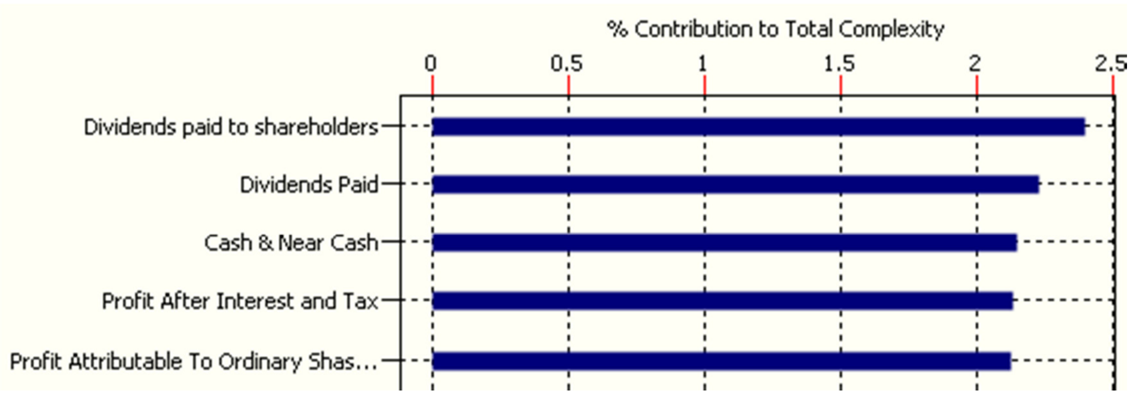
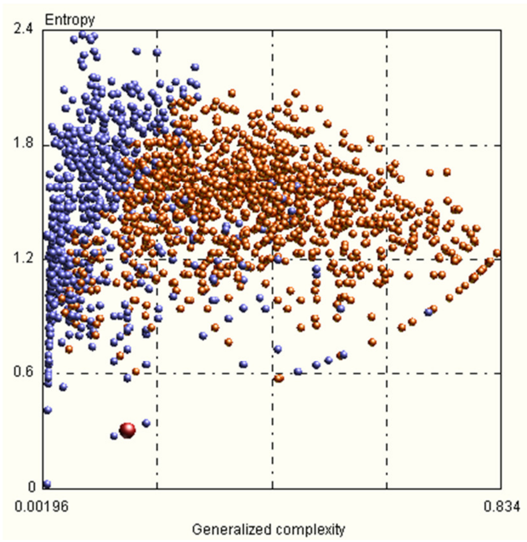


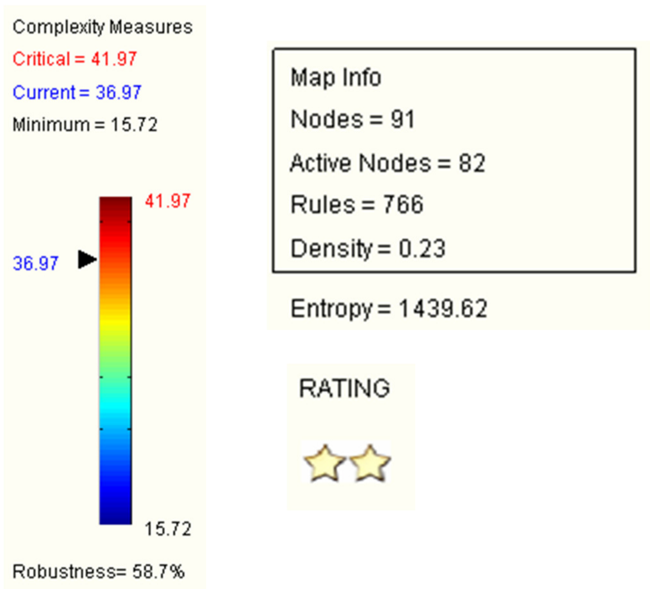
Figure 30: EOH Quick view (Entropy view)



The Entropy view shows the concentration (summary) of all the generalised correlation values between the variables.

6.1.4 Gijima (GIJ) Static Profile

The density of the complexity map is < 0.50 which indicates a low interdependency between measured items. This implies that change will be easily introduced in the system.



The Rating shows that the business is highly complex and difficult to manage and control. Exposure is high as well as inefficiency. The structure of the business is fragile hence vulnerable. It is difficult to make forecasts.

Figure 31: Set Contribution to Total Complexity of EOH

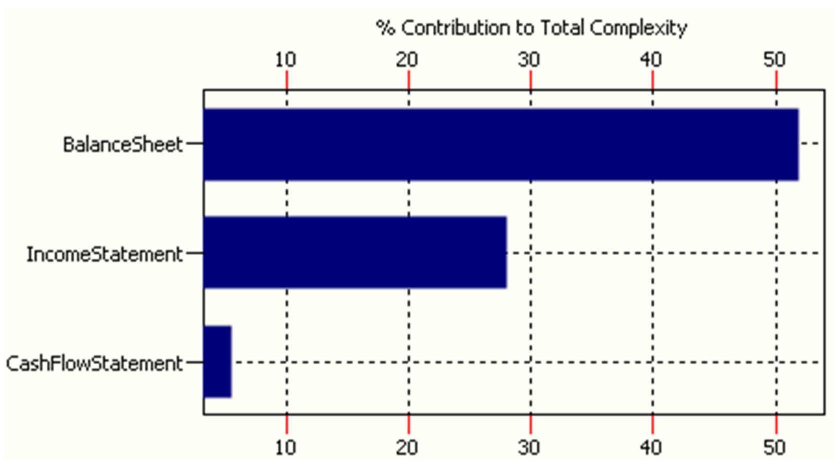


Figure 31 shows the set contribution to the total complexity whereas Figure 32 shows the top 5 complexity contributions of the system total complexity.

Figure 32: Top 5 Complexity Contributions of GIJ

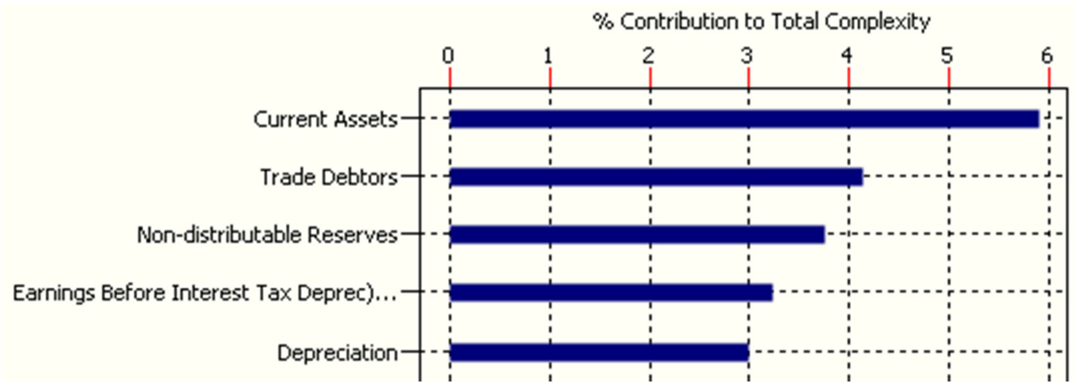
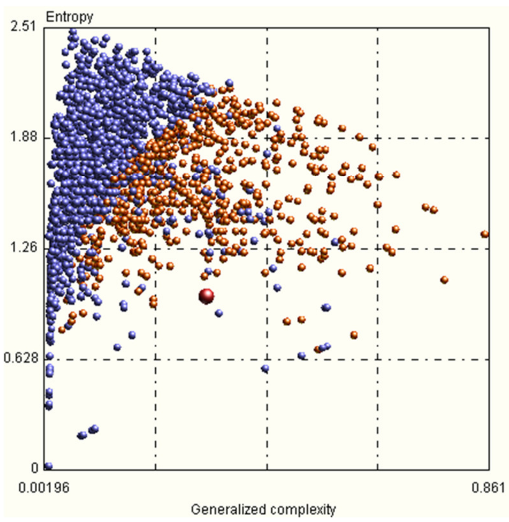


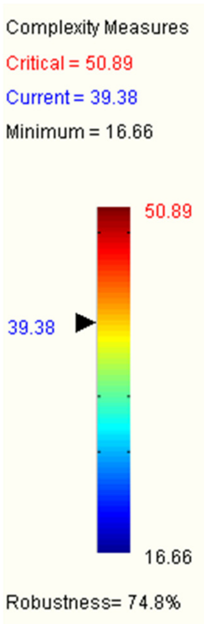
Figure 33: GIJ Quick view (Entropy view)

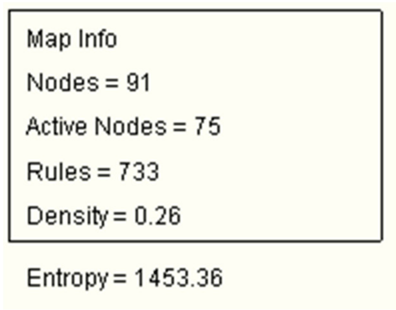


The Entropy view shows the concentration (summary) of all the generalised correlation values between the variables.

6.1.5 SecureData (SDH) Static Profile

The density of the complexity map is < 0.50 which indicates a low interdependency between measured items. This implies that change will be easily introduced in the system.





The Rating shows that business complexity is medium. The structure of the business is fairly robust. Performance predictability is acceptable. Exposure is moderate.

Figure 34: Set Contribution to Total Complexity of SDH

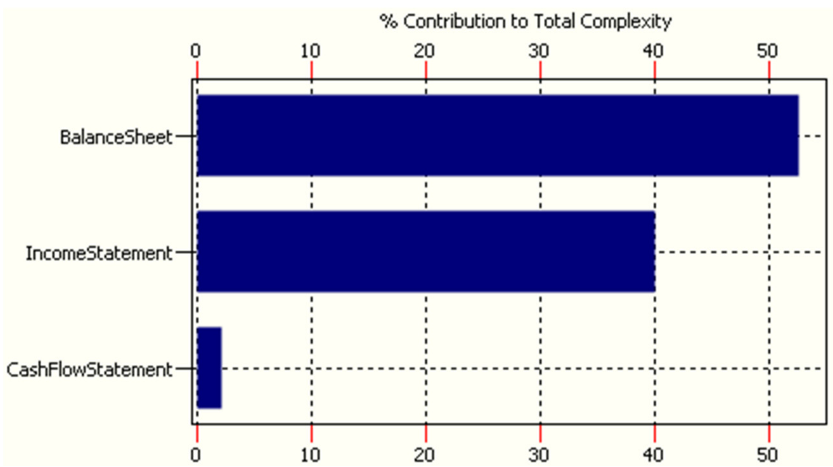


Figure 34 shows the set contribution to the total complexity whereas Figure 35 shows the top 5 complexity contributions of the system total complexity.

Figure 35: Top 5 Complexity Contributions of SDH

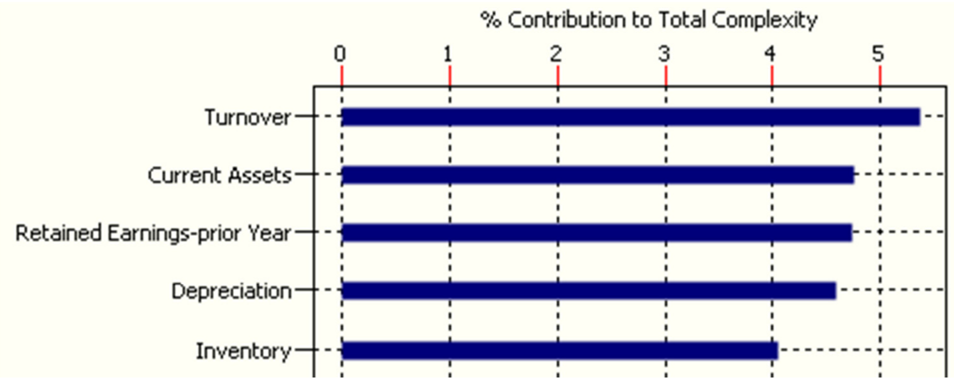
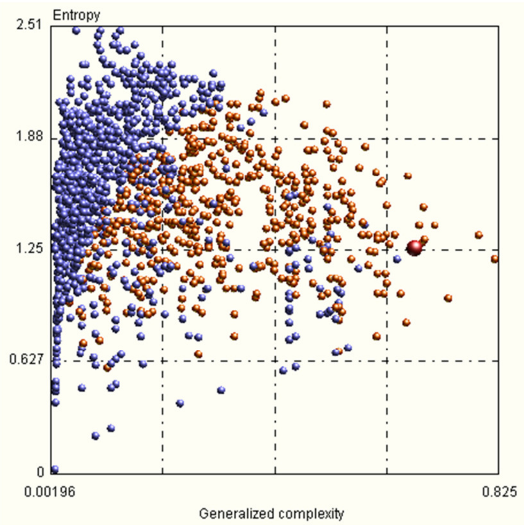


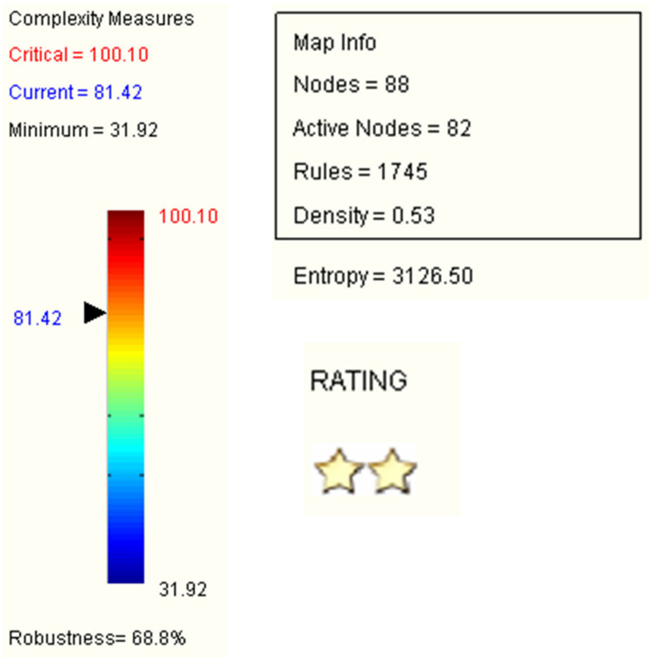
Figure 36: SDH Quick view (Entropy view)



The Entropy view shows the concentration (summary) of all the generalised correlation values between the variables.

6.1.6 UCS (UCS) Static Profile

The density of the complexity map is > 0.50 which indicates a high interdependency between measured items. This implies that change will be difficultly introduced in the system.



The business is highly complex and difficult to manage and control. Exposure is high as well as inefficiency. The structure of the business is fragile hence vulnerable. It is difficult to make forecasts.

Figure 37: Set Contribution to Total Complexity of UCS

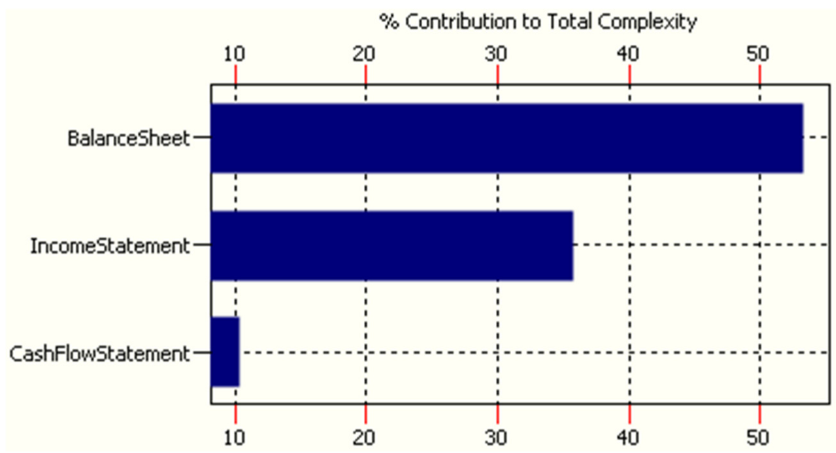


Figure 37 shows the set contribution to the total complexity whereas Figure 38 shows the top 5 complexity contributions of the system total complexity.

Figure 38: Top 5 Complexity Contributions of UCS

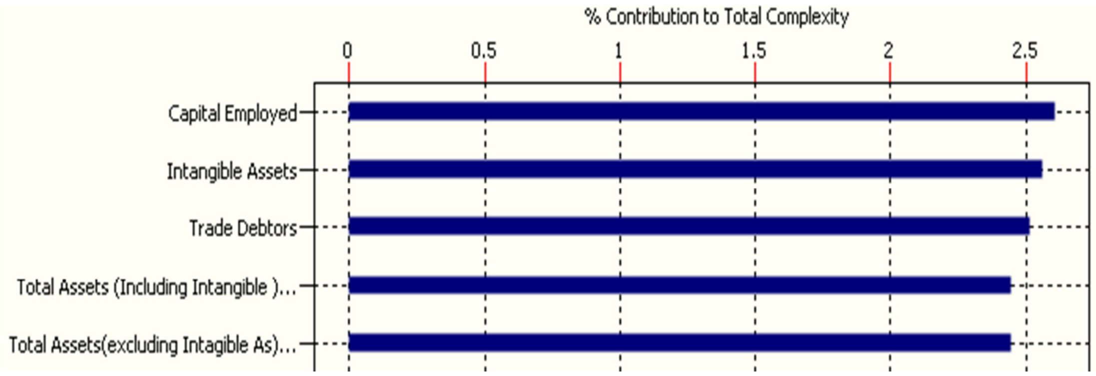
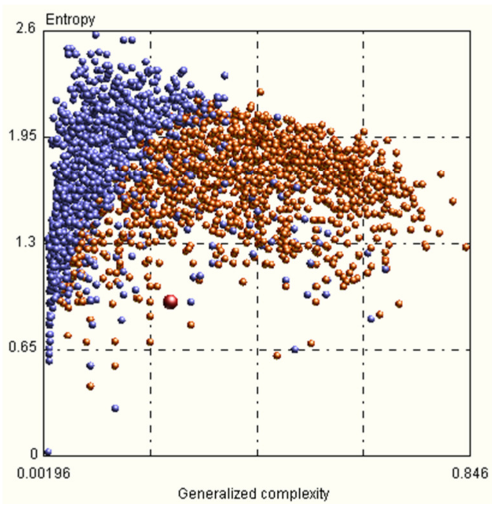


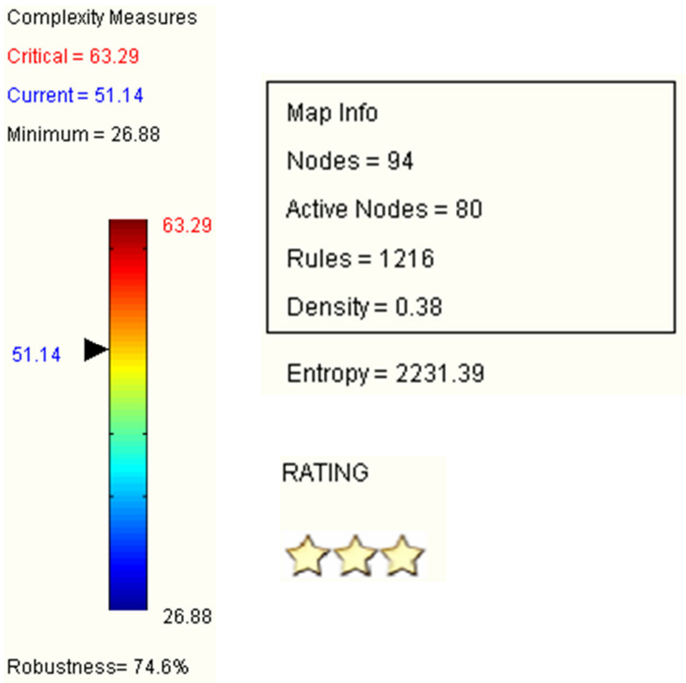
Figure 39: UCS Quick view (Entropy view)



The Entropy view shows the concentration (summary) of all the generalised correlation values between the variables.

6.1.7 Adaptit (ADI) Static Profile

The density of the complexity map is < 0.50 which indicates a low interdependency between measured items. This implies that change will be easily introduced in the system.



The Rating shows that the business is highly complex and difficult to manage and control. Exposure is high as well as inefficiency. The structure of the business is fragile hence vulnerable. It is difficult to make forecasts.

Figure 40: Set Contribution to Total Complexity of ADI

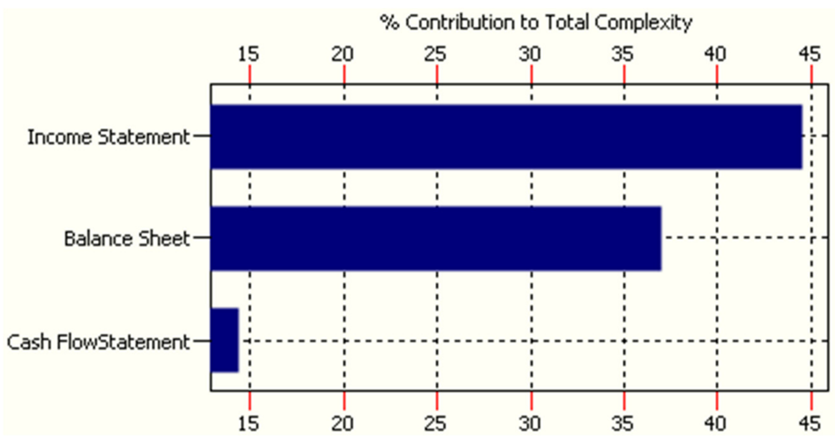


Figure 40 shows the set contribution to the total complexity whereas Figure 41 shows the top 5 complexity contributions of the system total complexity.

Figure 41: Top 5 Complexity Contributions of ADI

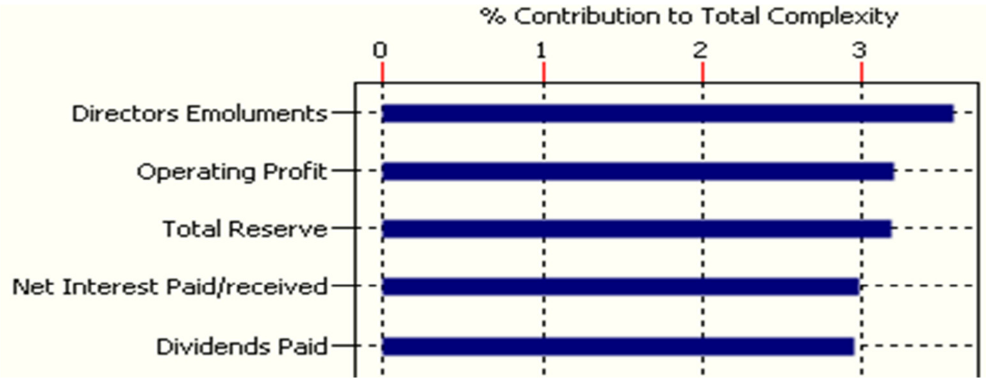
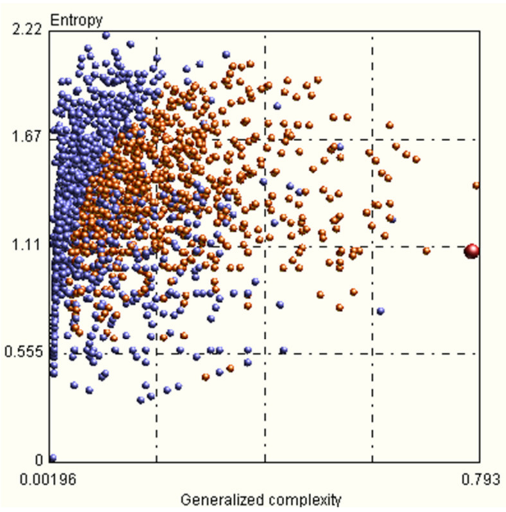


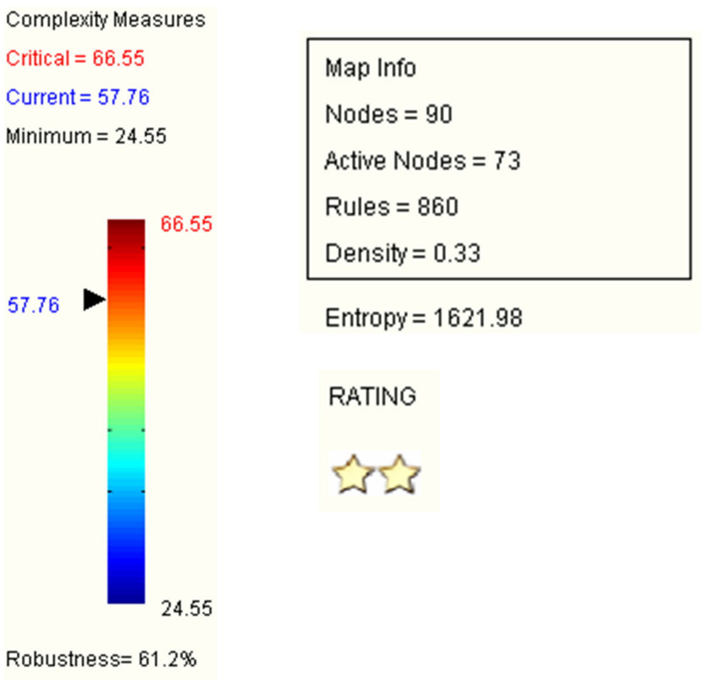
Figure 42: ADI Quick view (Entropy view)



The Entropy view shows the concentration (summary) of all the generalised correlation values between the variables.

6.1.8 Paracon (PCN) Static Profile

The density of the complexity map is < 0.50 which indicates a low interdependency between measured items. This implies that change will be easily introduced in the system.



The business is highly complex and difficult to manage and control. Exposure is high as well as inefficiency. The structure of the business is fragile hence vulnerable. It is difficult to make forecasts.

Figure 43: Set Contribution to Total Complexity of PCN

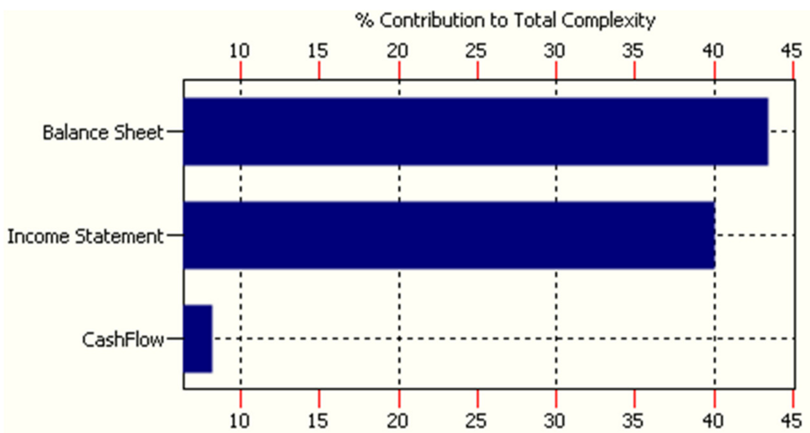


Figure 43 shows the set contribution to the total complexity whereas Figure 44 shows the top 5 complexity contributions of the system total complexity.

Figure 44: Top 5 Complexity Contributions of PCN

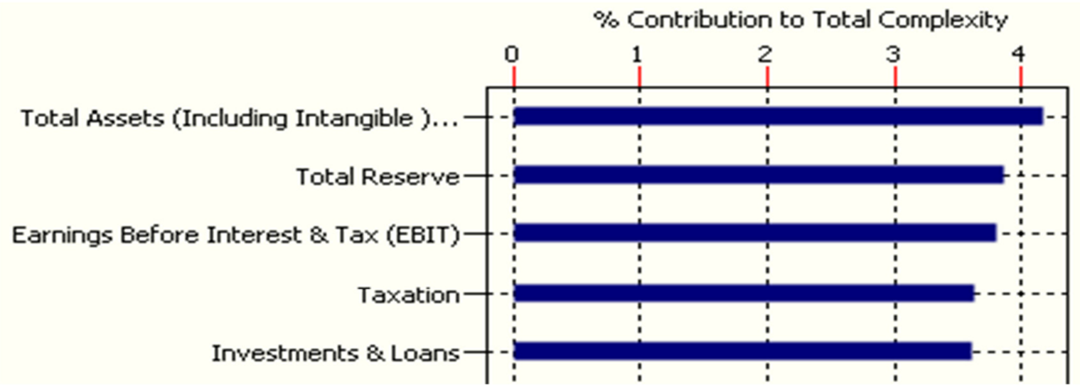
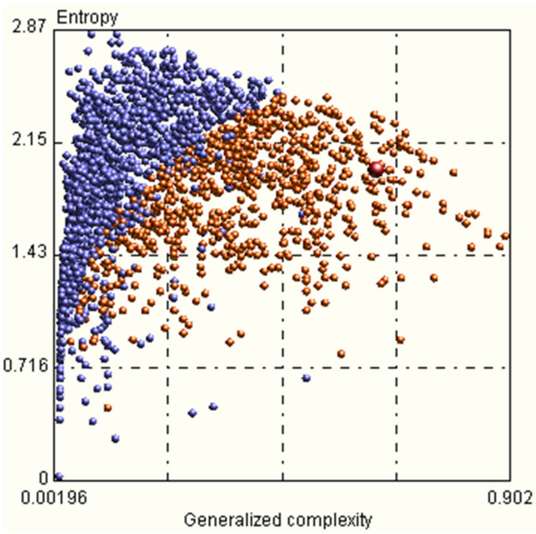


Figure 45: PCN Quick view (Entropy view)



The Entropy view shows the concentration (summary) of all the generalised correlation values between the variables.

6.2 Consolidated Findings

Each company respective static profiles were used to create a consolidated table that included the measurements required for the correlation analysis. See Table 1. The RONA% averages were calculated from the values in Appendix B.

Table 1: Consolidated Results from Static Analysis

	RONA% Average	Critical Complexity	Current Complexity	Robustness
DataCentrix	38.22	62.6	54.53	59.1
Datatec	17.37	75.81	50.12	85.9
EOH	80.28	107.2	61.65	78.3
Gijima	19.17	41.97	36.97	58.7
SecureData	81.22	50.89	39.38	74.8
UCS	54.49	100.1	81.42	68.8
Adaptit	56.04	63.29	51.14	74.6
Paracon	46.72	66.55	57.76	61.2

6.3 Correlation Analysis

A correlation analysis was done to determine whether a relationship exists between actual measured complexity, profitability and robustness in order to establish the predictive power of the relationship.

Figure 46: RONA and Complexity Relationship

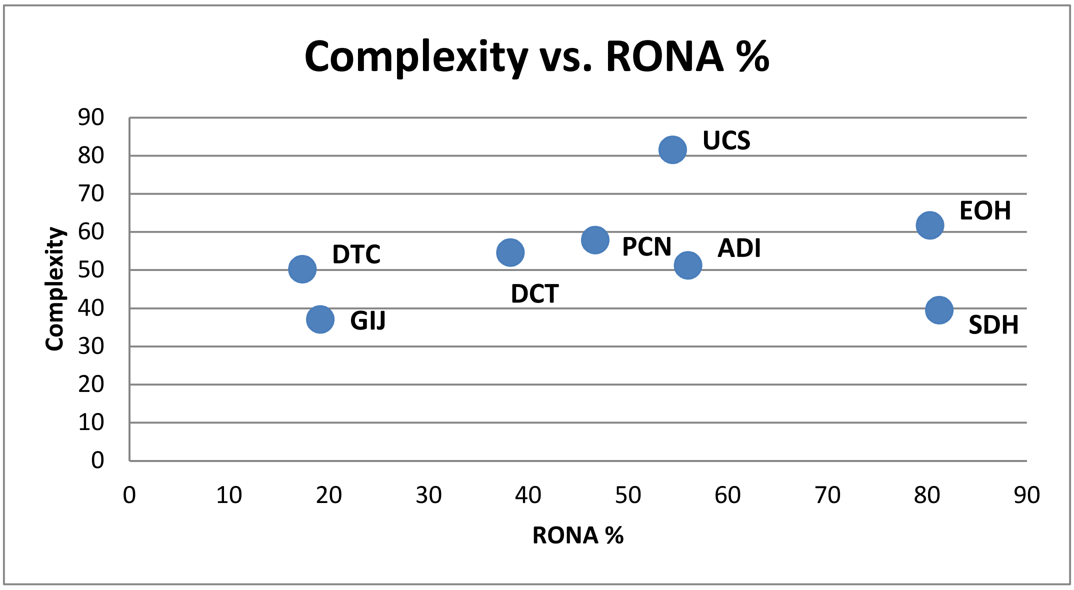
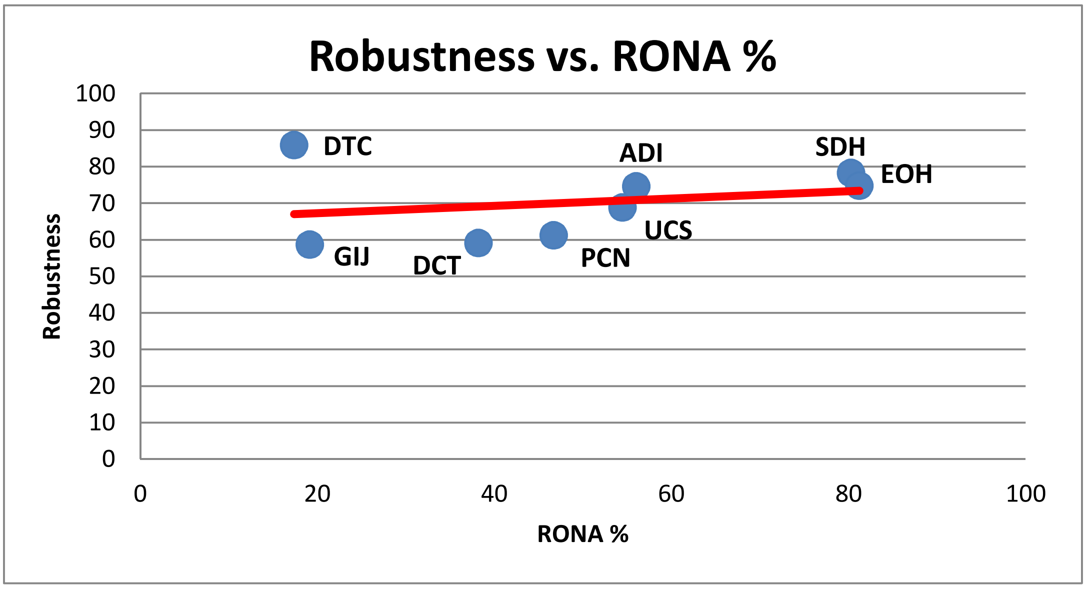


Figure 46 shows no clear relationship between actual measured complexity and profitability of the companies. However this does not mean that a relationship between complexity and profitability is absent. With the current amount of data points, no clear conclusion can be made on relationship between actual measured complexity and profitability on a business. Therefore a correlation analysis needs to be performed on the state of health of the company and its profit. This is based on the fact that complexity affects the health of a company and as a result impacts the profitability of a company.

Figure 47: RONA and Robustness Relationship

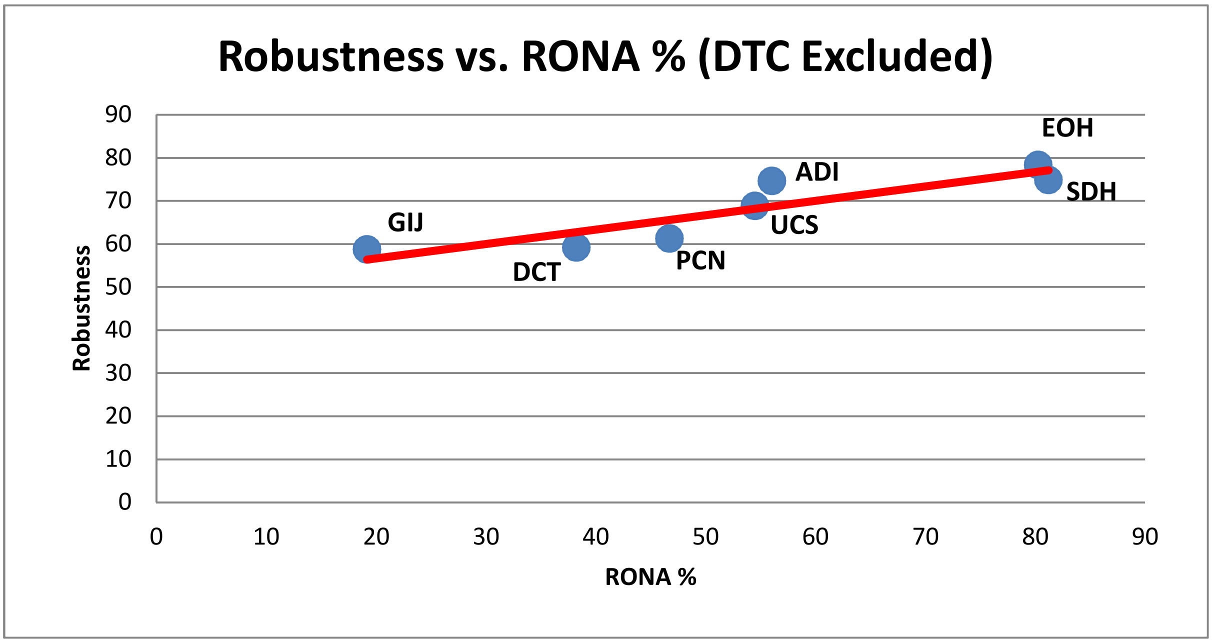


A correlation analysis was done to find the relationship between a company's profit and its robustness measure and the results indicated a low correlation of 0.244 existed when using the Pearson correlation coefficient for liner correlations. From observation in Figure 47, an irregularity or in statistical terms, an outlier was identified. Datatec had by far the best robustness but almost had the lowest RONA%. Believing that other factors are affecting the RONA% of Datatec, it was excluded from the second analysis and so a new correlation of 0.896 existed between the remaining companies, which is believed to be a very strong correlation. Thus indicating that the increase in robustness will lead to an increase in RONA%, see Table 2 and Figure 48.

Table 2: Correlation Analysis on RONA and Robustness

	Correlation
DTC Included	0.244266367
DTC Excluded	0.89577541

Figure 48: RONA and Robustness Relationship (DTC Excluded)



After identifying the companies that shows a strong relationship between Robustness and RONA%, and RONA% having two sub level measurements namely Profitability and Activity. Led to another correlation analysis on the sub level calculations of RONA%, see Table 4.

Table 3: Consolidated results (Excluding Datatec)

	RONA% Average	Critical Complexity	Current Complexity	Robustness	Profitability%	Activity
DataCentrix	38.22	62.6	54.53	59.1	5.17	507.64
EOH	80.28	107.2	61.65	78.3	9.79	787.71
Gijima	19.17	41.97	36.97	58.7	2.41	765.61
SecureData	81.22	50.89	39.38	74.8	13.92	761.02
UCS	54.49	100.1	81.42	68.8	15.59	435.43
Adaptit	56.04	63.29	51.14	74.6	18.43	333.83
Paracon	46.72	66.55	57.76	61.2	6.67	607.71

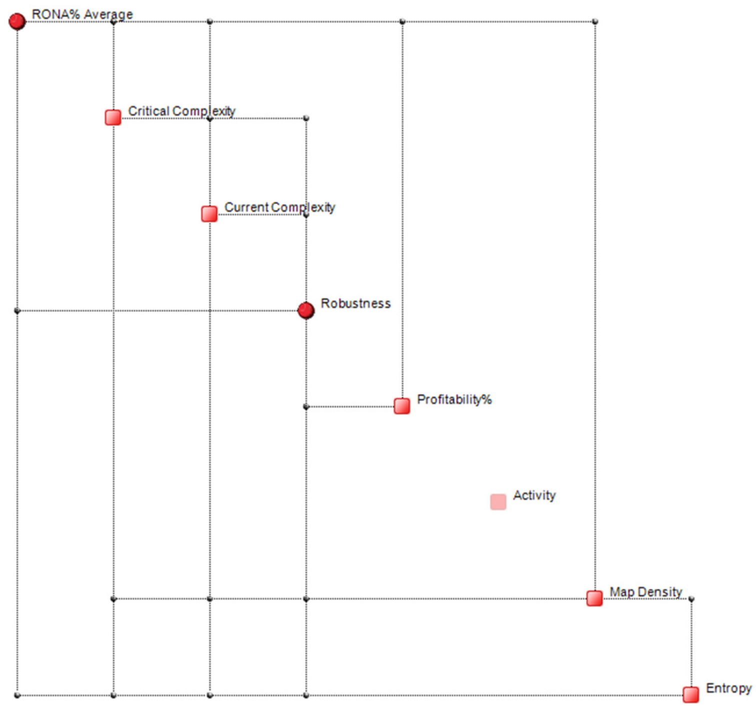
Table 4 shows the results obtained from the linear correlation analysis on the attributes of Table 3, showing whether another relationship exists between the sub level measurements of RONA% (Profitability% and Activity).

Table 4: Correlation Analysis on all properties calculated

	Correlation
RONA% vs. Critical Complexity	0.487275008
RONA% vs. Current Complexity	0.186233213
RONA% vs. Robustness	0.89577541
Profitability% vs. Critical Complexity	0.334381097
Profitability% vs. Current Complexity	0.346607122
Profitability% vs. Robustness	0.755940408
Activity vs. Critical Complexity	-0.123336662
Activity vs. Current Complexity	-0.465548241
Activity vs. Robustness	0.041369366

From Table 4 it is seen that the Profitability% is the main driver in the correlation between RONA% and robustness. The OntoSpace tool can measure generalised correlation and was also used to obtain a thorough conclusion on the relationship between the variables, see Figure 49.

Figure 49: Complexity Map of Correlation Variables



Only one relevant relationship was identified with a generalised correlation greater than 0.1. That relationship was the previously identified relationship between the RONA% average and Robustness, and had generalised correlation value of 0.542.

6.4 Conclusion of Consolidated Analysis

From the consolidated analysis it is clearly shown that complexity can be seen as a property that greatly affects a company profit. This is supported by the relationship that were identified between the performance metric (RONA%) and a complexity measure (robustness). The relationship had a linear correlation value of 0.9 which is considered as a strong relationship and a generalised correlation value of 0.542, and indicated that a mere 20% can increase RONA% by 60%. Thus showing sings that complexity management has great value as a tool to be used to increase profit.

6.5 Individual Analysis

A dynamic analysis was done to see how the complexity within the companies had grown over time (studied period), in order to compare the results with the respective companies' RONA% growth over time, and to determine if there were signs to explain the companies' RONA% performance. Figure 51 to Figure 57 shows the respective companies' complexity histories and from these figures an overall increase of complexity can be seen as time progressed showing that complexity is truly increasing in the business world. Figure 59 to Figure 66 shows the respective companies' robustness histories, which indicates how the companies' ability to handle uncertainty changed over time. Figure 67 to Figure 73 shows the respective companies' entropy histories, which indicates how structures grew or broke within the companies over the years. The values used to create the RONA% figures can be found in Appendix B.

Complexity History

Figure 50: Complexity History of Datacentrix

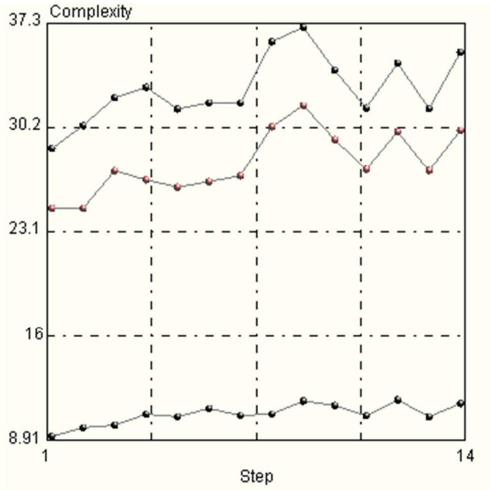


Figure 51: Complexity History of Datatec

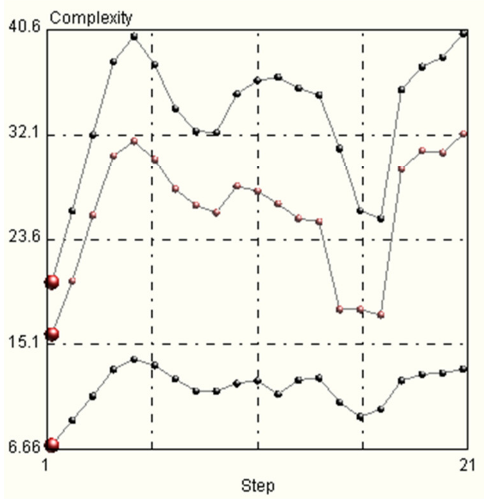


Figure 52: Complexity History of EOH

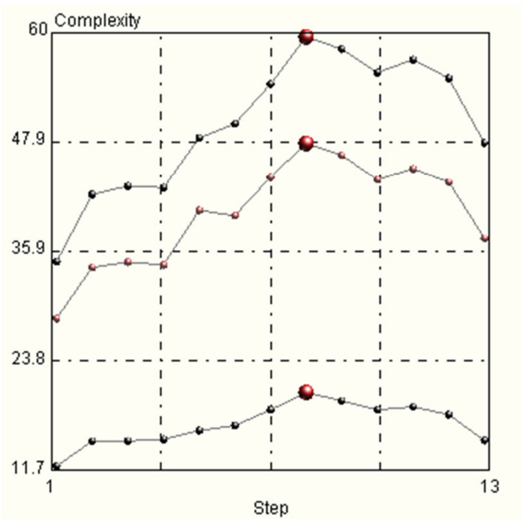


Figure 53: Complexity History of Gijima

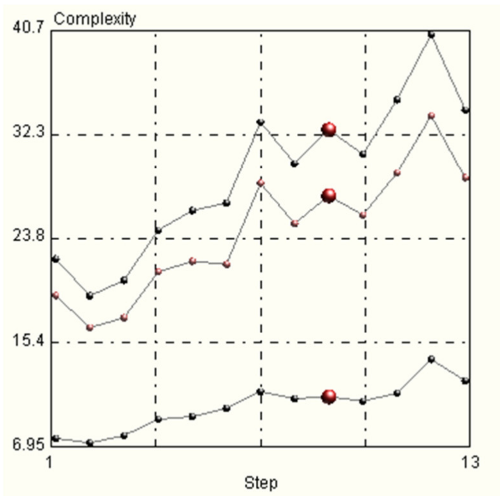


Figure 54: Complexity History of Adaptit

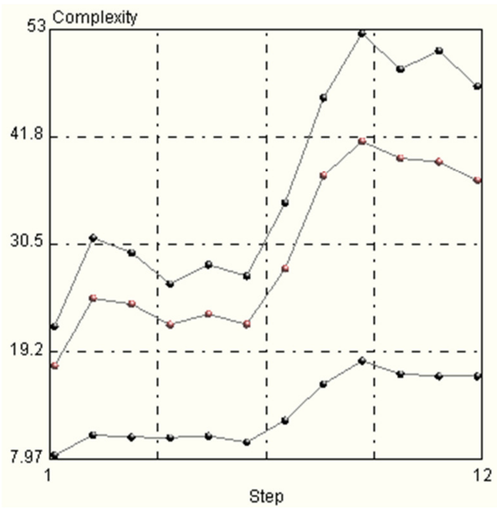


Figure 55: Complexity History of Paracon

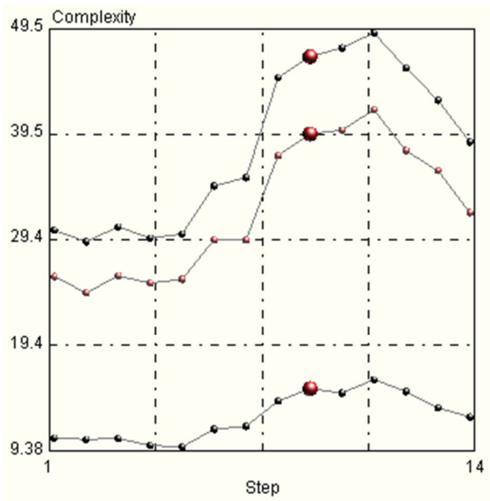


Figure 56: Complexity History of SecureData

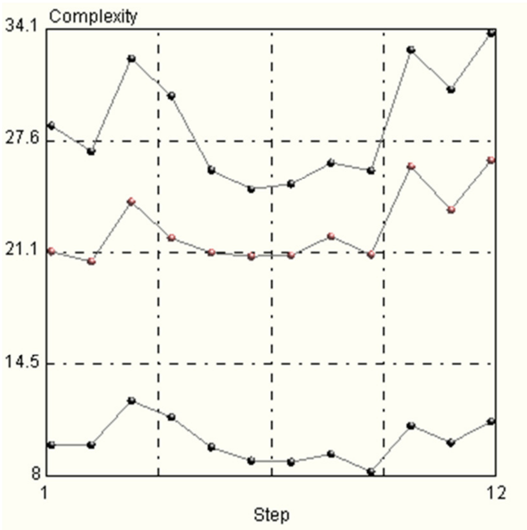


Figure 57: Complexity History of UCS

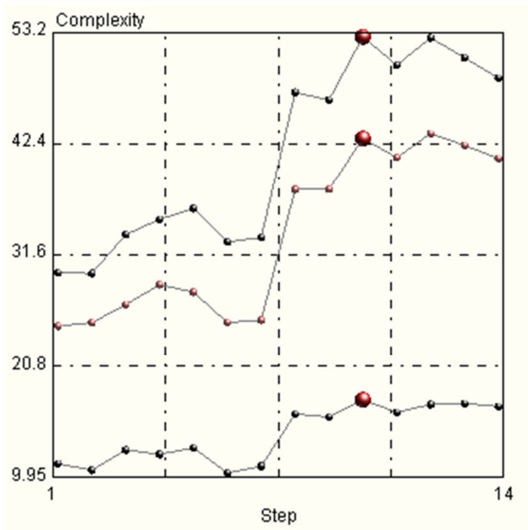
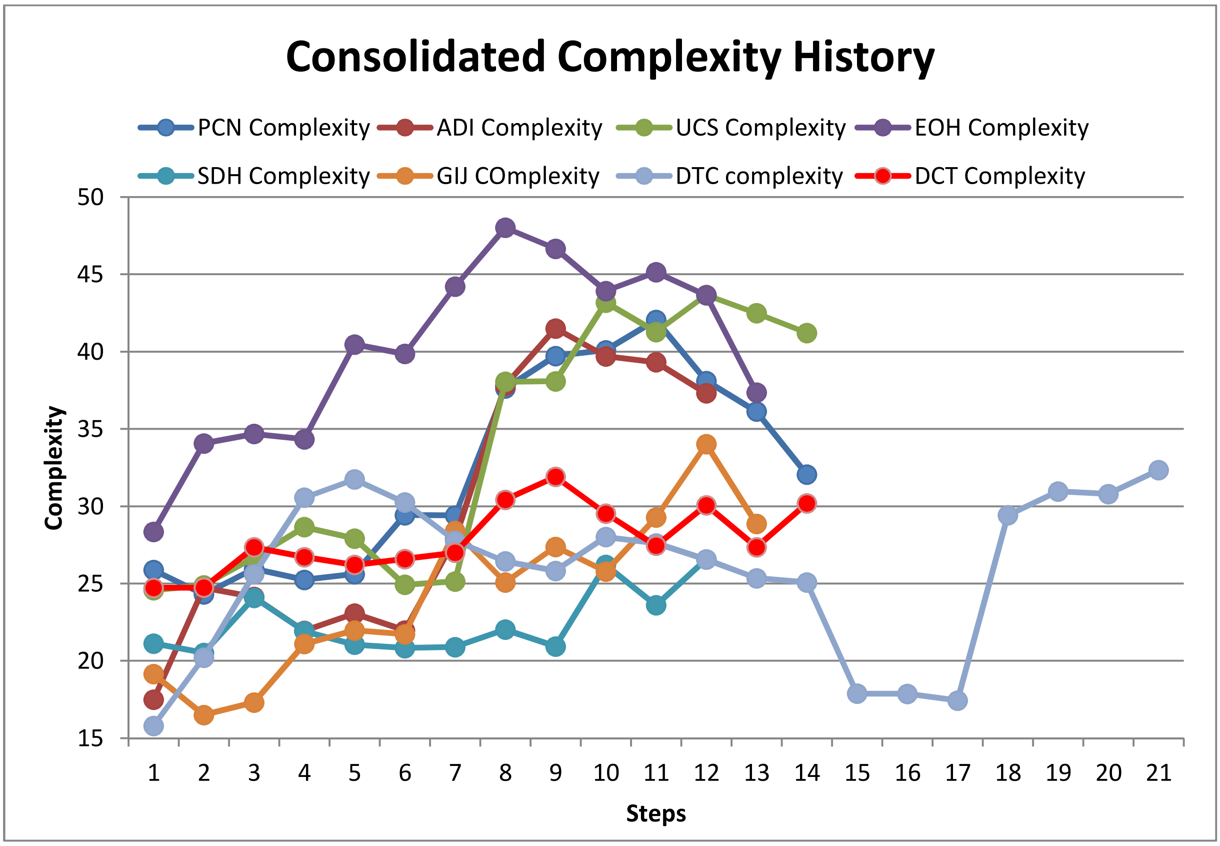


Figure 58: Summary on the complexity history



Robustness History

Figure 59: Robustness History of Datacentrix

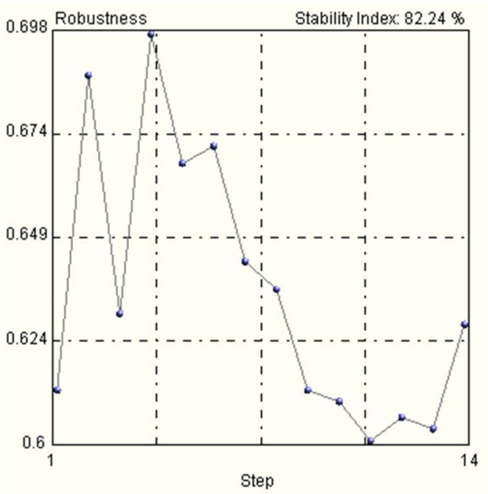


Figure 60: Robustness History of Datatec

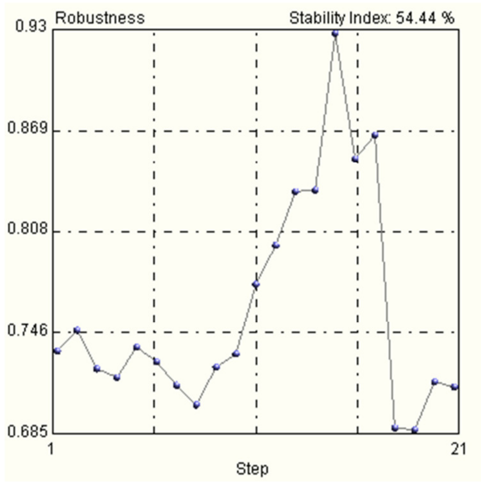


Figure 61: Robustness History of EOH

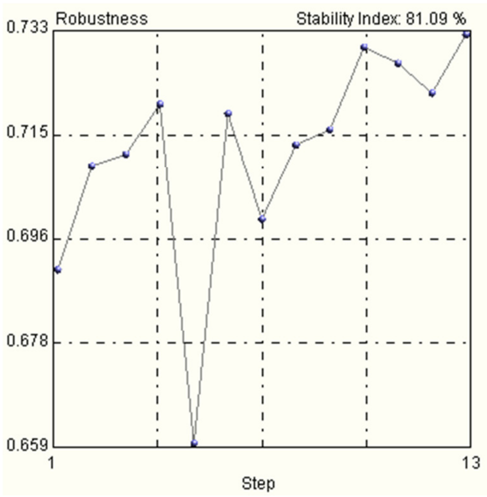


Figure 62: Robustness History of Gijima

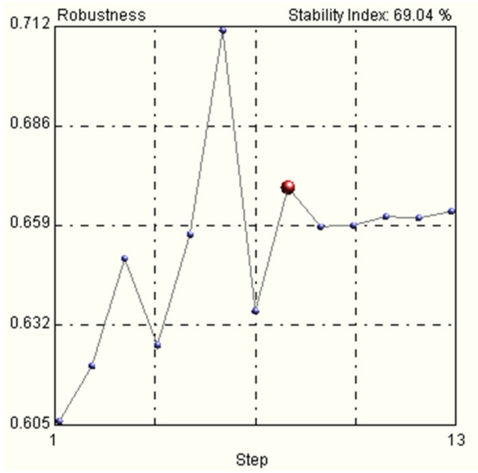


Figure 63: Robustness History of SecureData

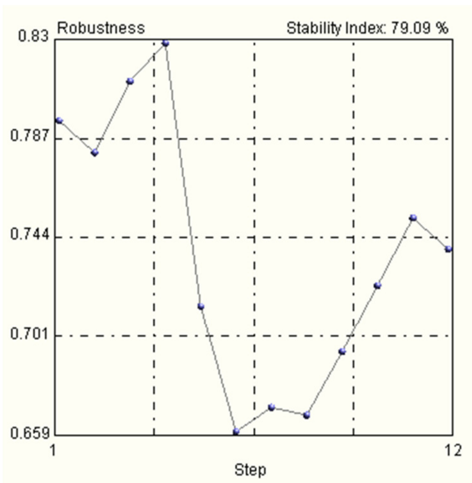


Figure 64: Robustness History of UCS

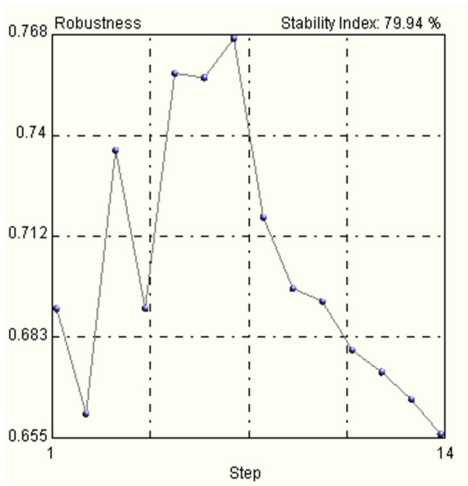


Figure 65: Robustness History of Adaptit

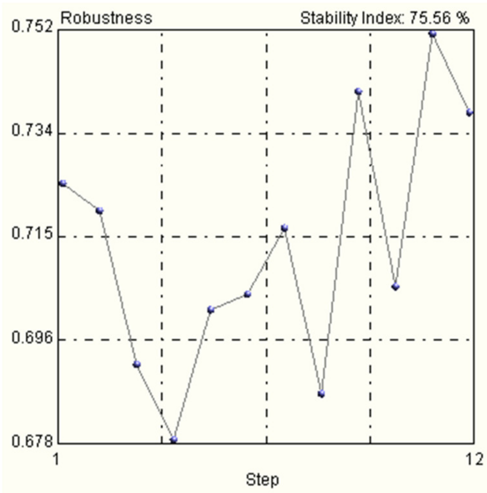
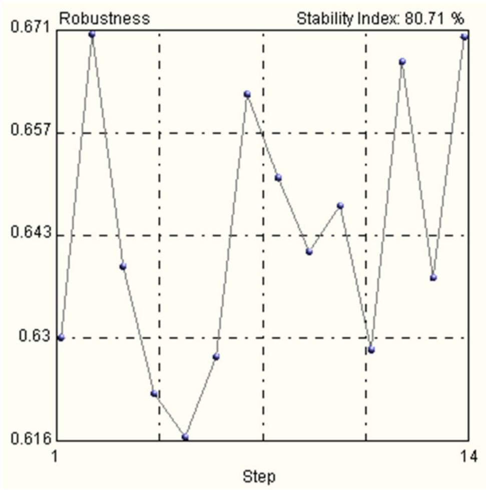


Figure 66: Robustness History of Paracon



Entropy History

Figure 67: Entropy History of Datacentrix

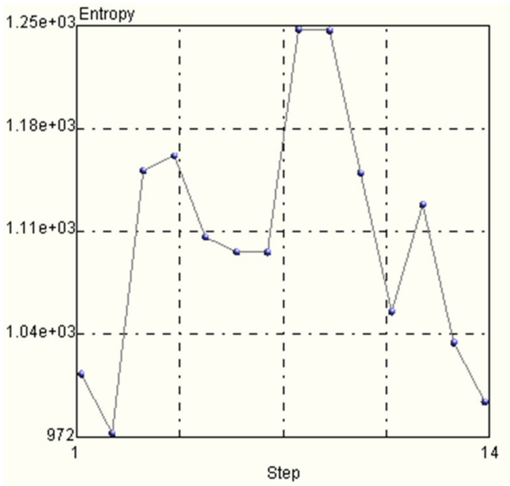


Figure 68: Entropy History of Datatec

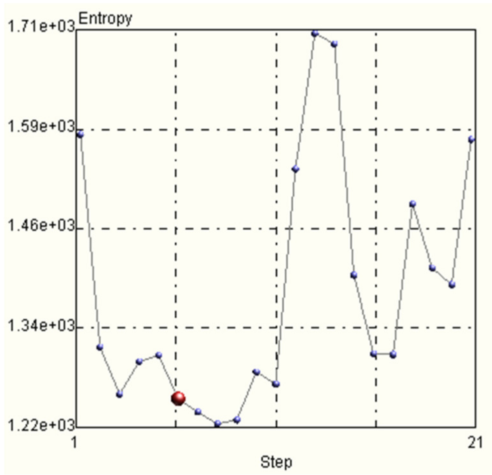


Figure 69: Entropy History for EOH

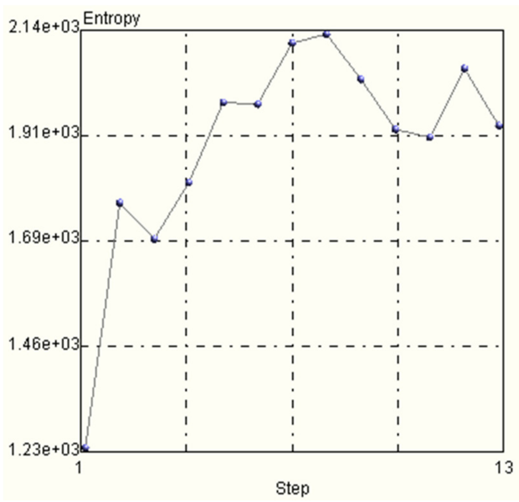


Figure 70: Entropy History of Gijima

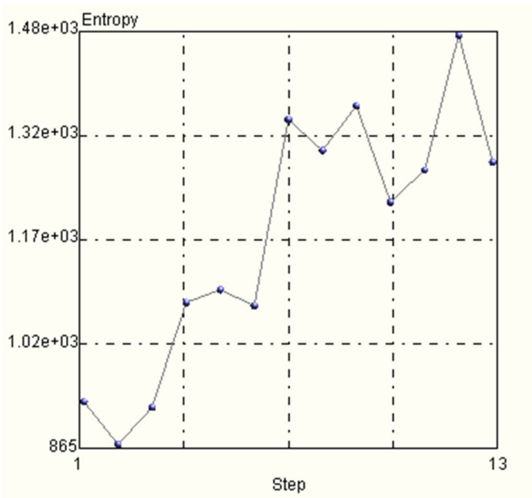


Figure 71: Entropy History of SecureData

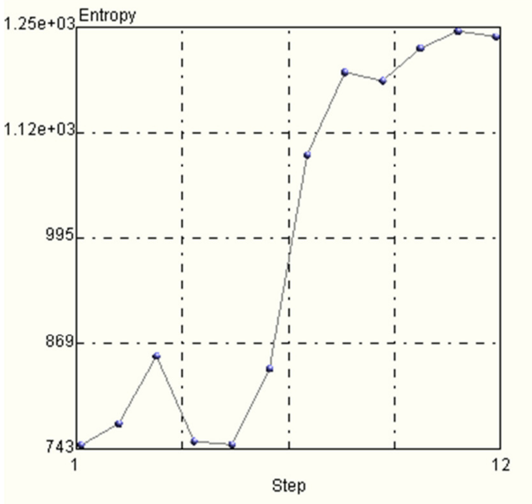


Figure 72: Entropy History of UCS

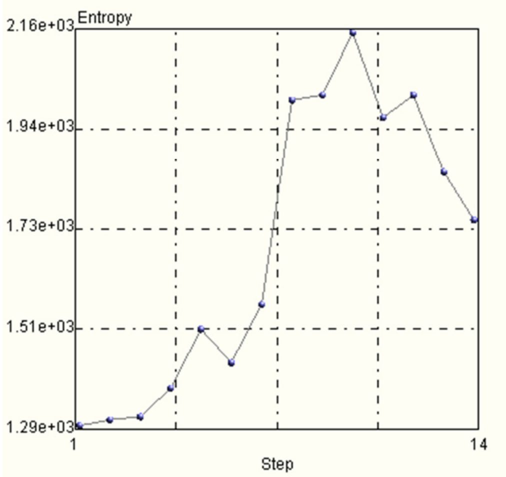


Figure 73: Entropy History of PCN

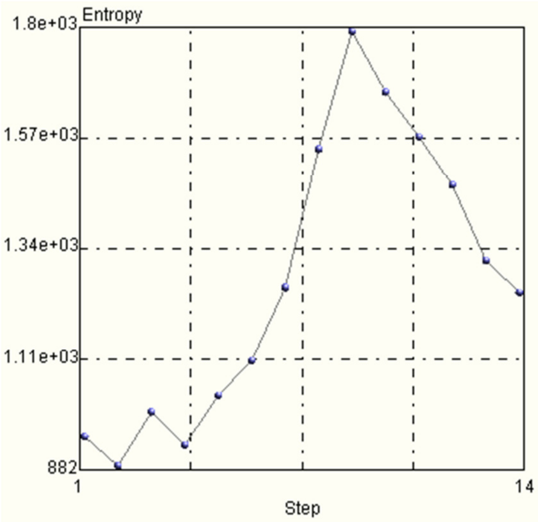
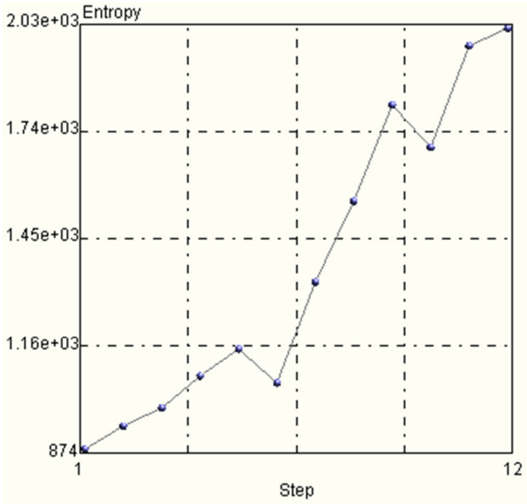


Figure 74: Entropy History of ADI



6.5.1 Datacentrix (DCT)

Datacentrix dynamic analysis was done with a widow size of 12 and overlap of 11, giving 14 steps. These 14 steps represents the 1999 to 2011 period that was studied of Datacentrix.

Figure 75: Complexity and Robustness History of DCT

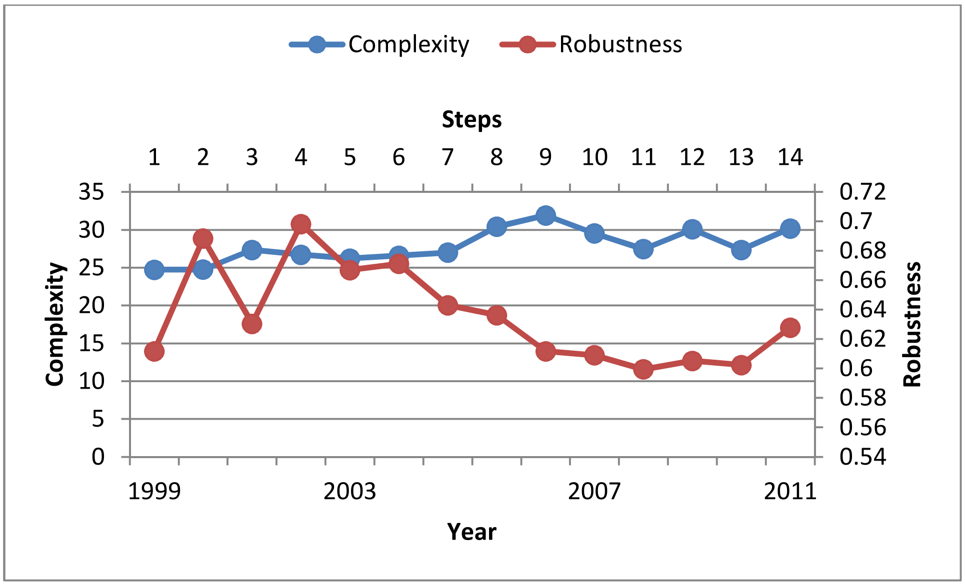
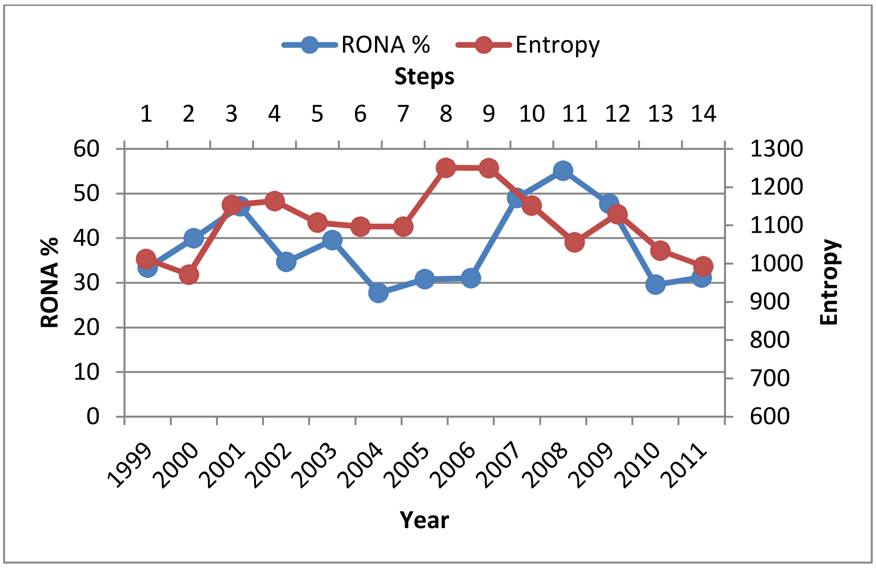
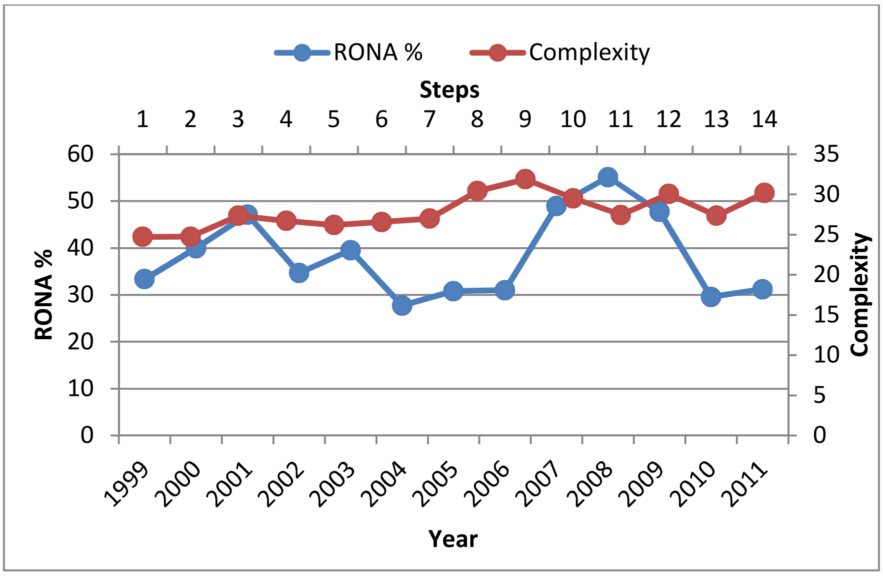


Figure 76: RONA% and Entropy History of DCT



From Figure 75 a somewhat consistent complexity history can be seen as well a consistent robustness history as indicated by a stability index of 82.24%. This stability should reflect on the company profit in a comparable way. From Figure 76 a build-up of entropy is visible to a point where it suddenly goes down, this normally indicates a breakdown in the system structure and should have impact on the business profit.

Figure 77: RONA% and Complexity History of DCT



From Figure 77 one can see that there exists a similar stability in the RONA% and complexity history and that this similarity can also be seen from Figure 76, given that when the entropy suddenly decreased, which normally indicates a break in structure, the RONA% also decreased.

6.5.2 Datatec (DTC)

Datatec dynamic analysis was done with a widow size of 12 and overlap of 11, giving 21 steps. These 21 steps represents the 1995 to 2011 period that was studied of Datatec.

Figure 78 shows a fluctuated complexity history and as indicated a by the stability index of 54.44%, a good but somewhat unstable robustness history. This complexity and robustness variance should show a similar inconsistency in the RONA% history of the company. Also form Figure 79 a sudden increase and decrease in the entropy is identified, which indicates a sudden change in structure and should be reflected in the company RONA% history.

Figure 78: Complexity and Robustness History of DTC

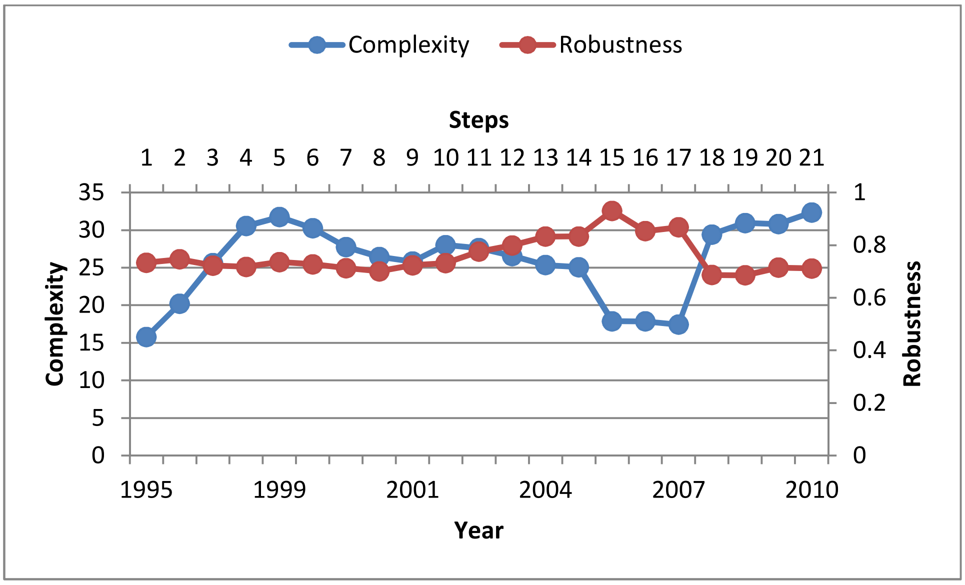
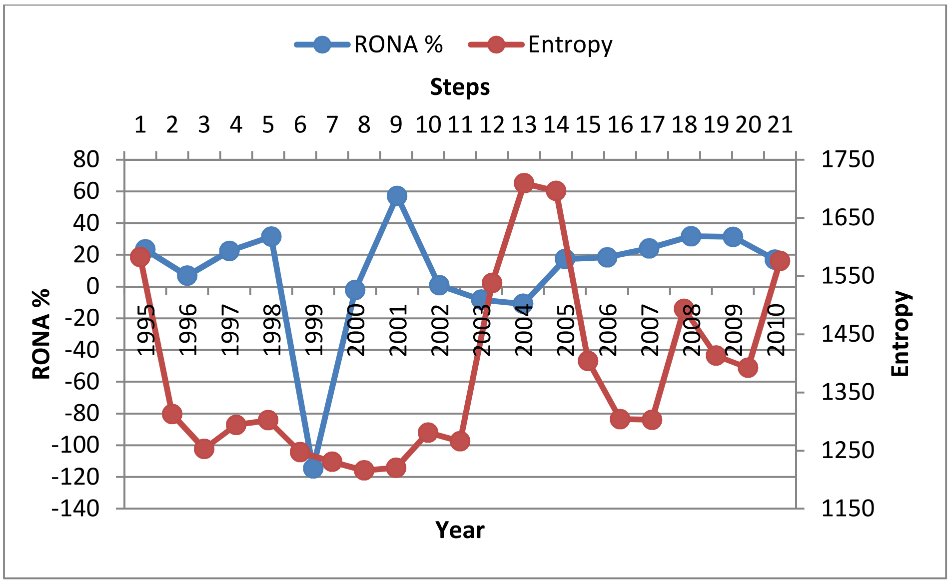


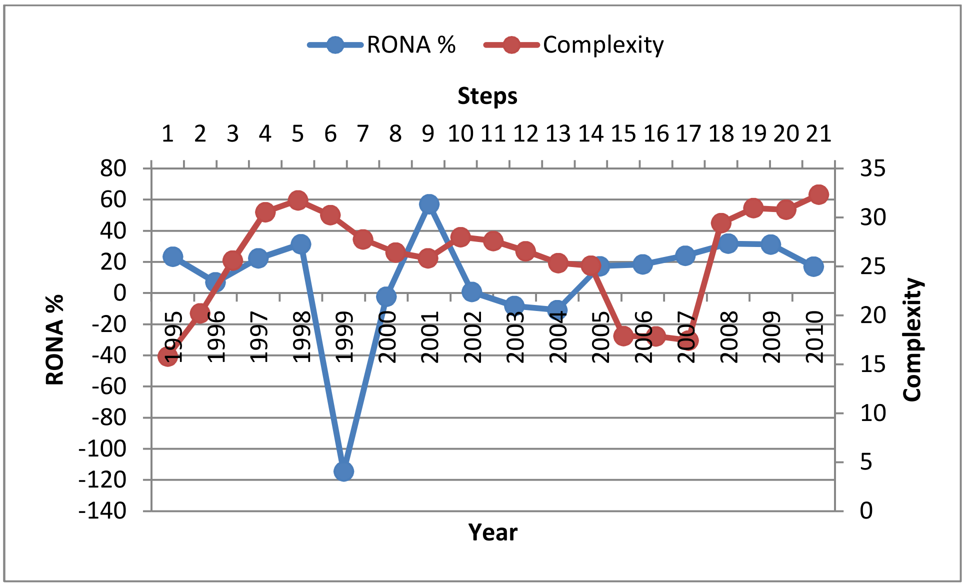
Figure 79: RONA% and Entropy History of DTC



When looking at Figure 78 and Figure 80 the similar unstable characteristics can be identified in the figure. Indicating when the complexity was at its min increasing to its max, the RONA% also increased slowly to the point when the business suddenly crashed to a shocking

-114%. This crash is also supported by the sudden increase and decrease in entropy in Figure 79 which indicates a breaking structure.

Figure 80: RONA% and Complexity History of DTC



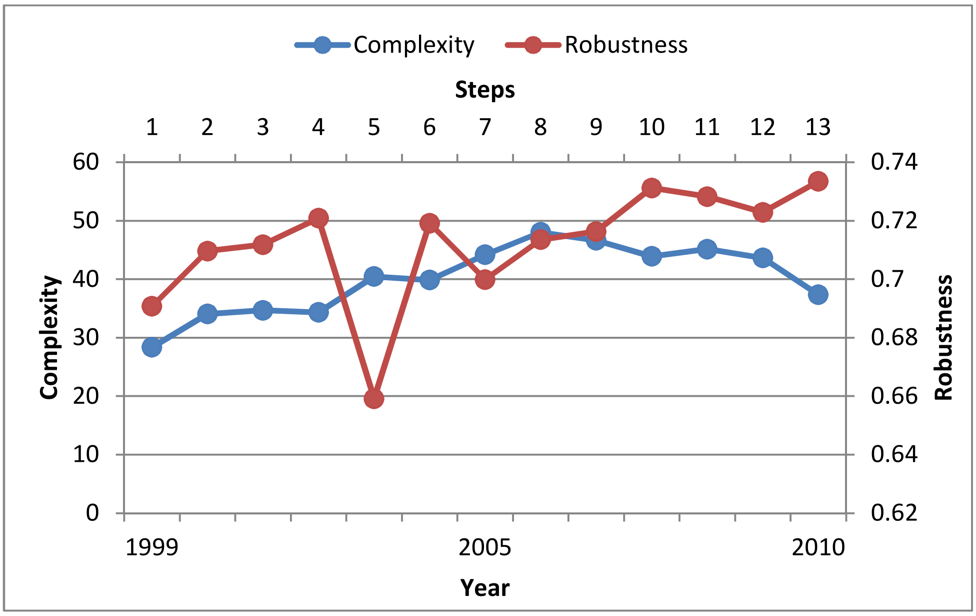
In the period of 2004 to 2009, a slow increase in RONA is seen. This increase is supported by the company complexity and robustness history, which is shown in Figure 78 at step 14 to 19. At 14 to 19 the complexity is decreasing and robustness is increasing, showing that the company is in a healthy position which is reflected by the company steady increase in RONA%.

6.5.3 EOH (EOH)

EOH dynamic analysis was done with a widow size of 12 and overlap of 11, giving 13 steps. These 13 steps represents the 1999 to 2010 period that was studied of EOH.

From Figure 81 a slow and steady increase in the complexity and robustness is identified, where the robustness has a stability index of 81.09%. This increase of complexity in combination with the increasing and stable robustness should show a similar overall RONA% increase over time and decrease where complexity were too high or too close to its critical complexity.

Figure 81: Complexity and Robustness History of EOH



From Figure 82 an increase of entropy can be seen when complexity increases over time to the point where the complexity stabilizes just as the entropy in the system. This clearly shows the relationship between complexity and entropy in the system, and also shows that there were no sudden changes or breakdowns in the system structure and should reflect similarly on the company RONA% performance.

Figure 82: RONA% and Entropy History of EOH

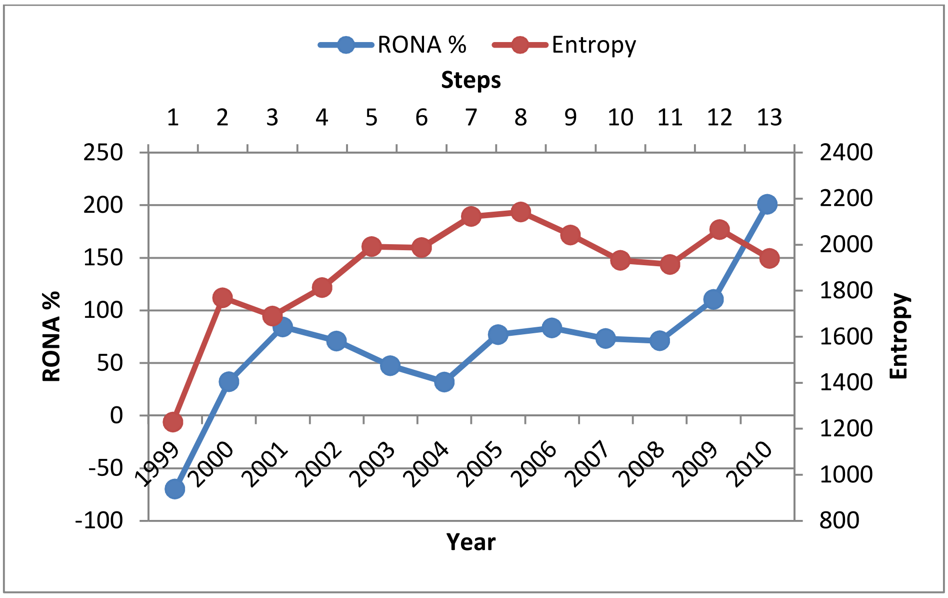


Figure 83: RONA% and Complexity History of EOH

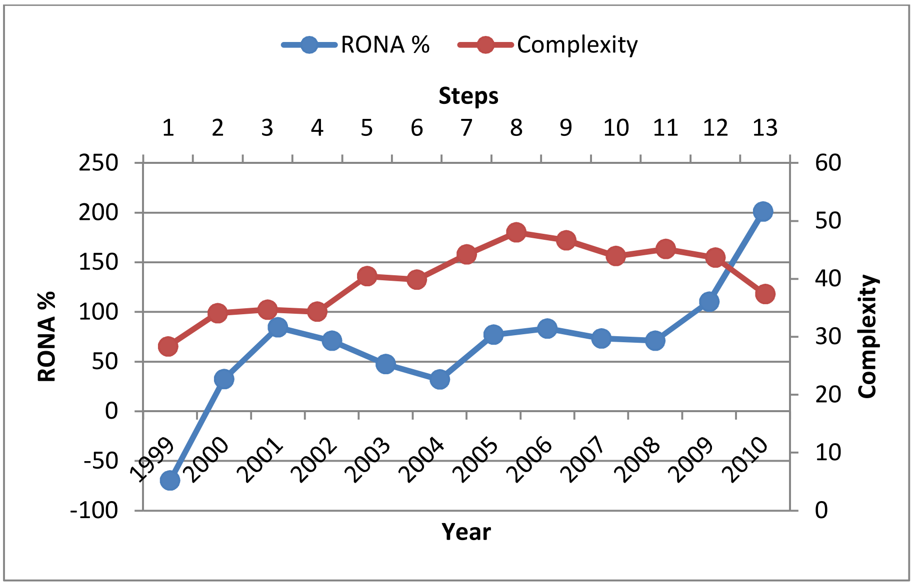


Figure 83 shows an overall increase in RONA, which consists of smaller increases and decreases. For analysis purposes the figure is dived into two parts, where the first part is from period 1999 to 2004 and the second from 2005 to 2010. These parts are represented by step 1-7 and 8-13 in the history figures. From the first part a short sharp grow in RONA is seen that is followed by a steady decrease in the RONA. This is supported in the complexity and robustness history figure at step 1-4 where complexity is steady and robustness is increasing. This shows that the company ability to sustain uncertainty is increasing while complexity is stable and as a result the company is becoming more sustainable. In step 4-7 the complexity is increasing while the robustness is fluctuating, this indicates the company ability to sustain uncertainty is decreasing and is reflected by the decrease in the RONA%.

From the second part an overall RONA% growth is seen, which is also supported by the complexity and robustness history figure. The figure shows that the complexity slightly decreases over time while the robustness is increasing and as a result making the business healthier and more sustainable. This result creates opportunities to increase company profit drastically as seen in last few years.

6.5.4 Gijima (GIJ)

Gijima dynamic analysis was done with a widow size of 12 and overlap of 11, giving 13 steps. These 13 steps represents the 2000 to 2010 period that was studied of Gijima.

Figure 84: Complexity and Robustness History of GIJ

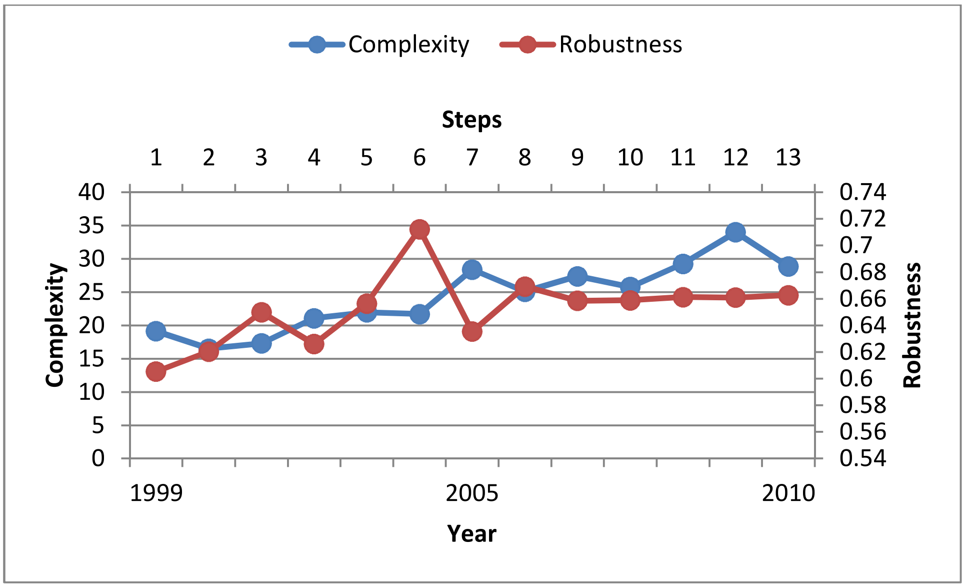


Figure 84 shows a steady increase of complexity over time as well as a sudden increase of robustness that stabilizes over time. The robustness history has a stability index of 69.04%.

Figure 85: RONA% and Entropy History of GIJ

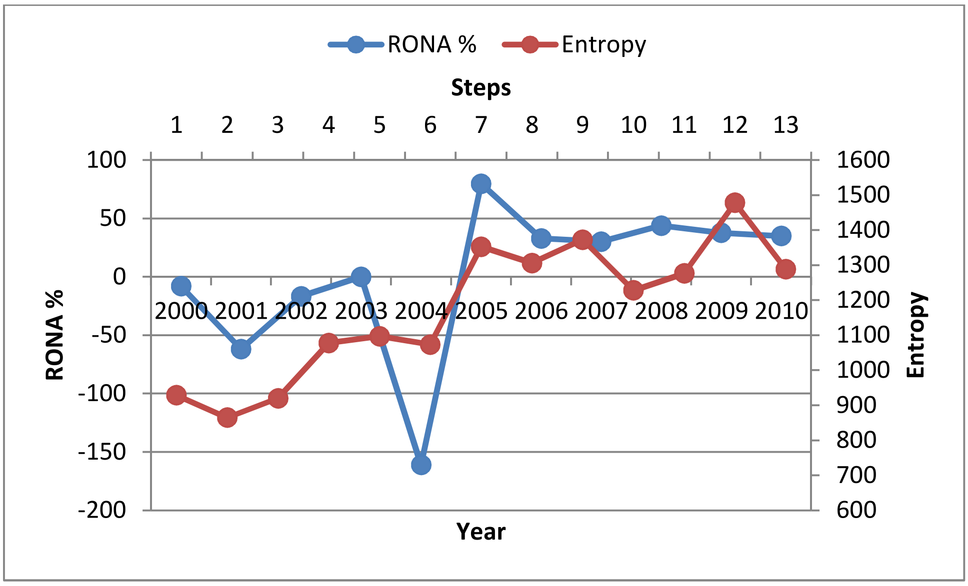
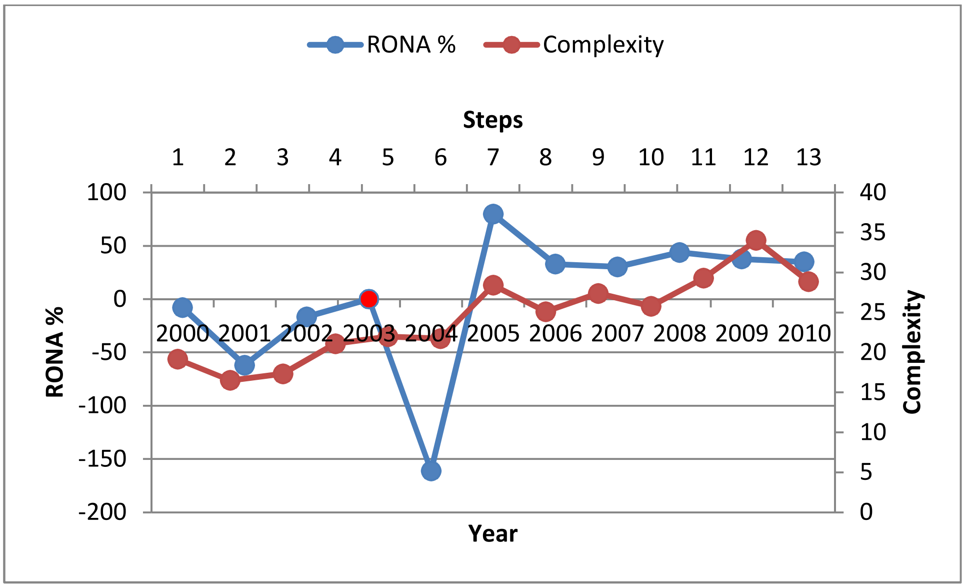


Figure 86: RONA% and Complexity History of GIJ



Note: In 2003 the Current Liabilities exceeded the combined value of the Fixed and Current Assets of the company, and is indicated by a red dot in

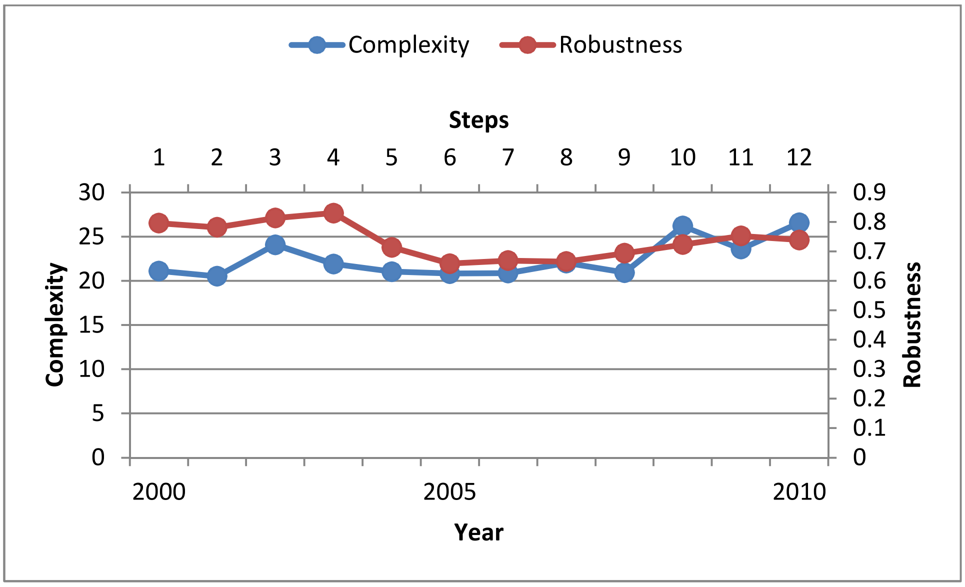
Figure 86 and a zero in Table 12. This was most likely caused by the adjacent negative returns from the previous years that resulted in the debt of the company to increase. Thus for Analysis purposes will 2004 be seen as a second starting point the company. In

Figure 86 a stable RONA is seen from 2006-2010, this is supported by the stable Complexity, Robustness and Entropy history at step 7-13.

6.5.5 SecureData (SDH)

SecureData dynamic analysis was done with a widow size of 12 and overlap of 11, giving 13 steps. These 13 steps represents the 2000 to 2010 period that was studied of SecureData.

Figure 87: Complexity and Robustness History of SDH



A fairly consistent complexity history is seen in Figure 87 as well as a very good and stable robustness history as indicated by the stability index of 79%. The same stability should reflect on the company RONA% performance.

Figure 88: RONA% and Entropy History of SDH

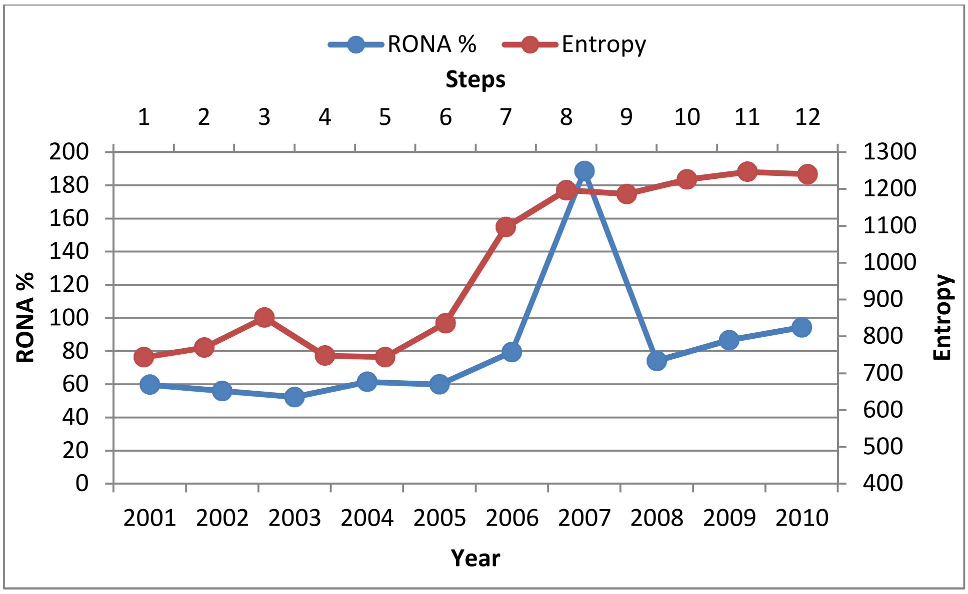
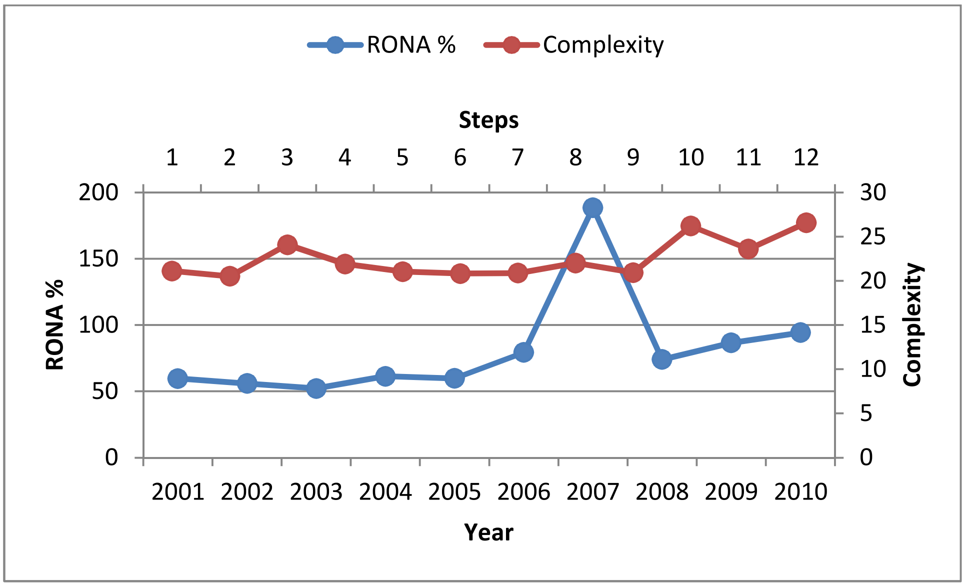


Figure 89: RONA% and Complexity History of SDH



In Figure 89 the same stability can be seen in the RONA% history of the company when compared with the complexity and robustness history, thus clearly showing the relationship between the complexity measures and the company's performance.

6.5.6 UCS (UCS)

UCS dynamic analysis was done with a widow size of 12 and overlap of 11, giving 14 steps. These 14 steps represents the 1998 to 2010 period that was studied of UCS.

Figure 90: Complexity and Robustness History of UCS

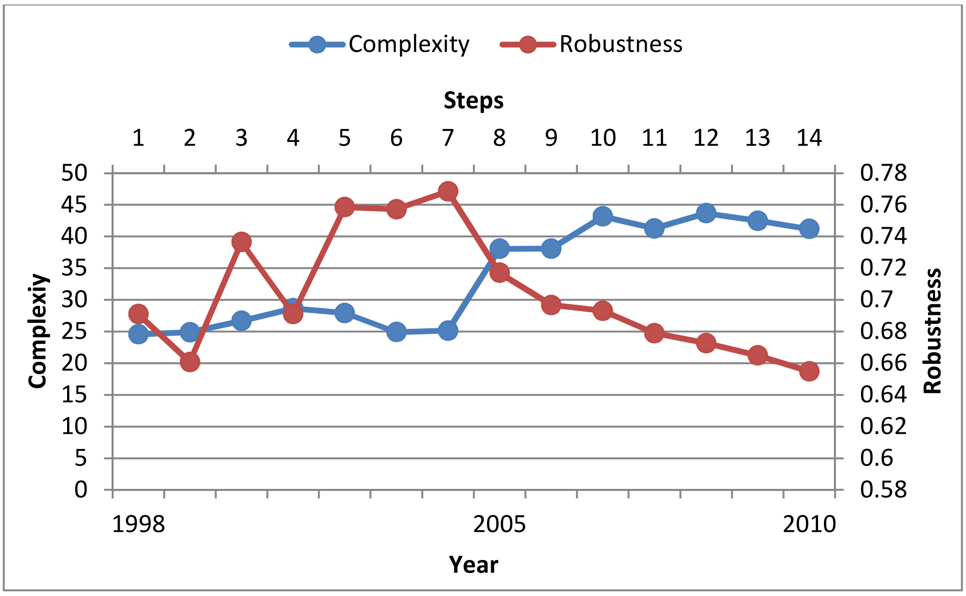


Figure 91: RONA% and Entropy History of UCS

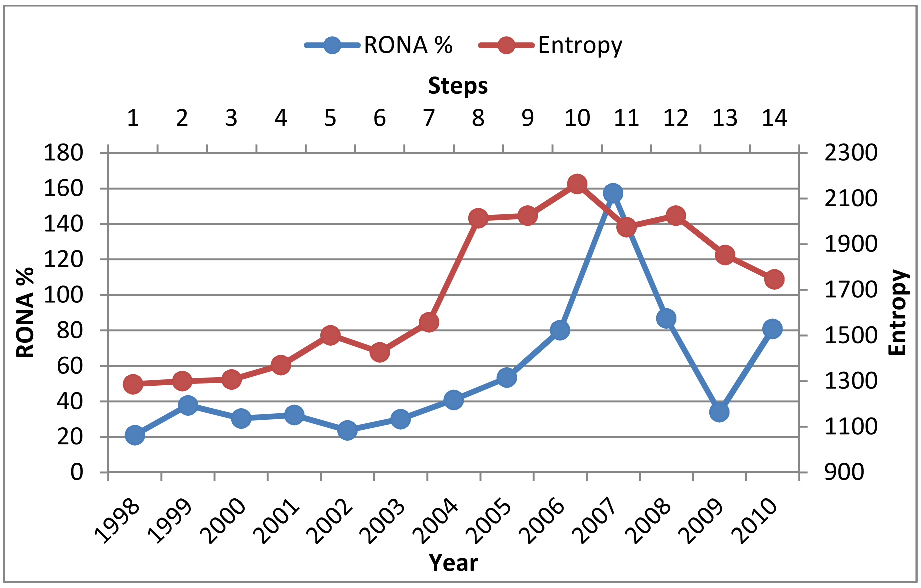
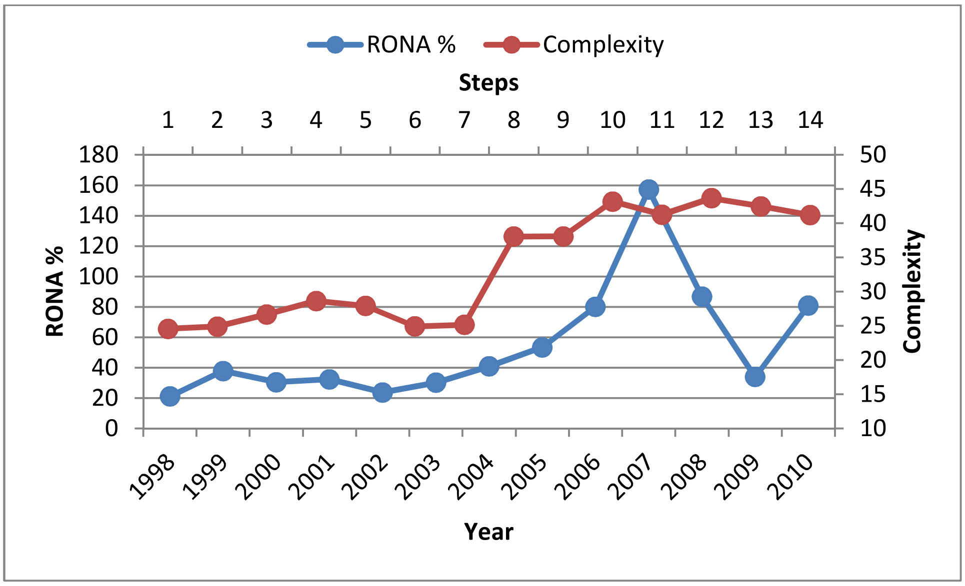


Figure 92: RONA% and Complexity History of UCS



In Figure 90 an overall increase of complexity is seen as well as a good and stable robustness history as indicated by the stability index of 79.94%. When comparing the complexity, robustness and entropy histories (Figure 90 and Figure 91) with the company's RONA% performance, a similar pattern is visible. As the complexity is increasing combined with the robustness that is also increasing, a steady increase in RONA% is seen up to the point where robustness starts to drop while complexity is still increasing resulted in the RONA% drop. This is also supported by the entropy history (Figure 91) which is shows an increase in entropy over time up to the point where the entropy starts to drop, this indicates that a structure is breaking as seen in the sudden drop in RONA%

6.5.7 Adaptit (ADI)

Adaptit dynamic analysis was done with a widow size of 12 and overlap of 11, giving 12 steps. These 12 steps represents the 1999 to 2010 period that was studied of Adaptit.

In Figure 93 an overall increase of complexity is seen as well as a good and stable robustness history as indicated by the stability index of 75.56%. Figure 93 shows that when complexity increased the robustness also increased, indicating that the company is in a healthy potion and should reflect similarly on the company's RONA% performance over time.

Figure 93: Complexity and Robustness History of ADI

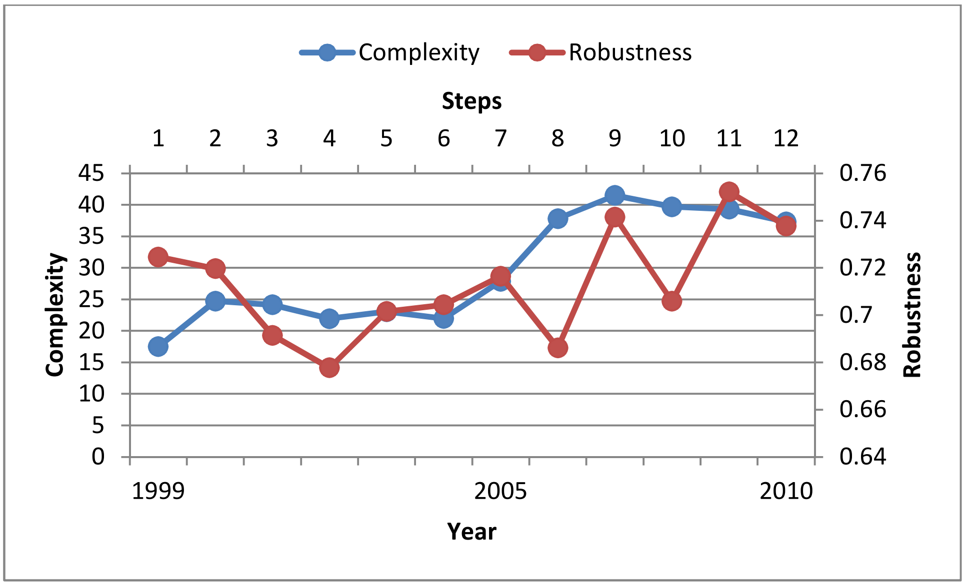


Figure 94: RONA% and Entropy History of ADI

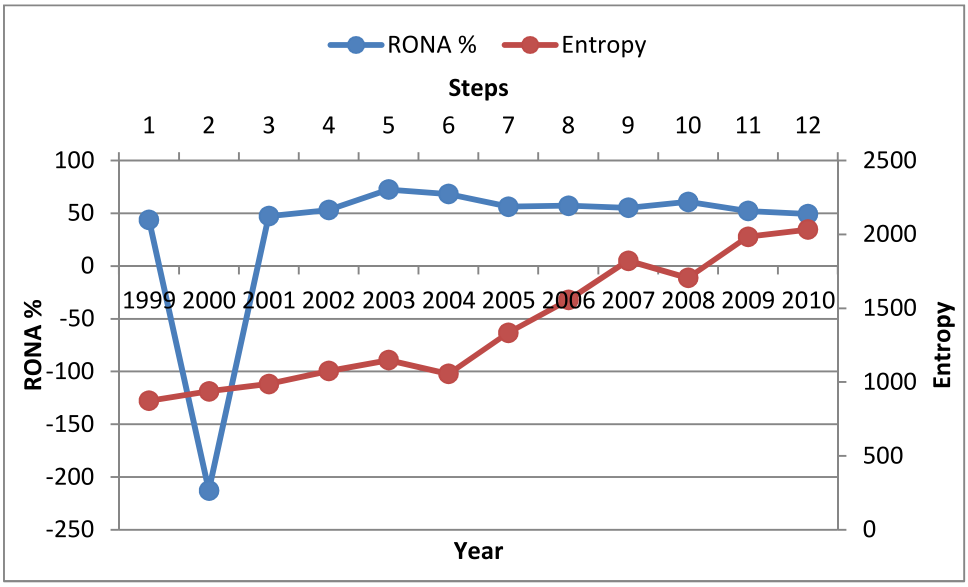
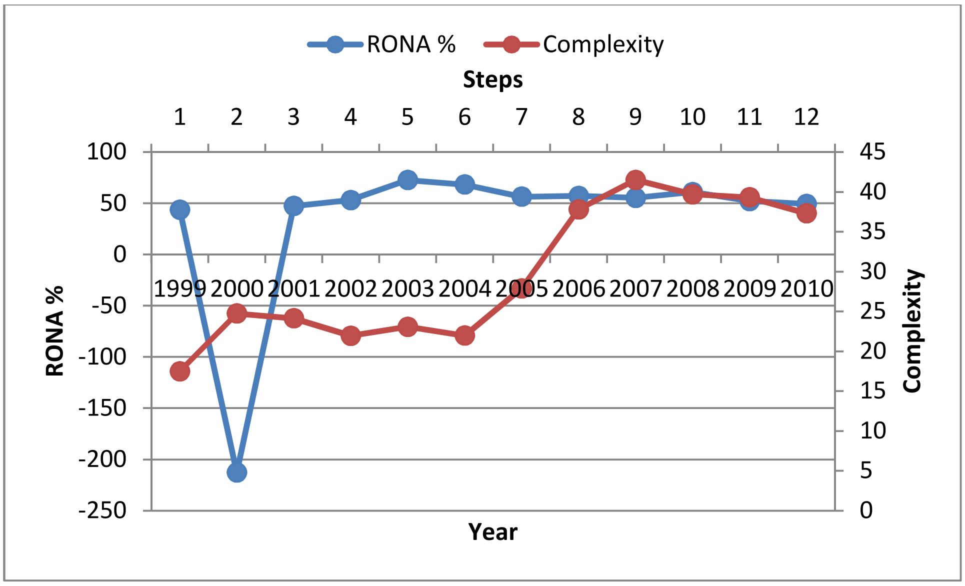


Figure 94 shows a steady increase in entropy history as time progressed this is also supported by the steady increase of complexity in the complexity history figure.

Figure 95: RONA% and Complexity History of ADI



From Figure 95 a steady RONA% performance is seen over the years accept for the year 2000 where the RONA% was a shocking -212.83%. Regarding this data point as an irregularity that is affecting the scale of the figure, a new figure was created to illustrate a more detailed representation of the measurements. See Figure 96.

Figure 96: RONA% and Complexity History of ADI (Closer look)

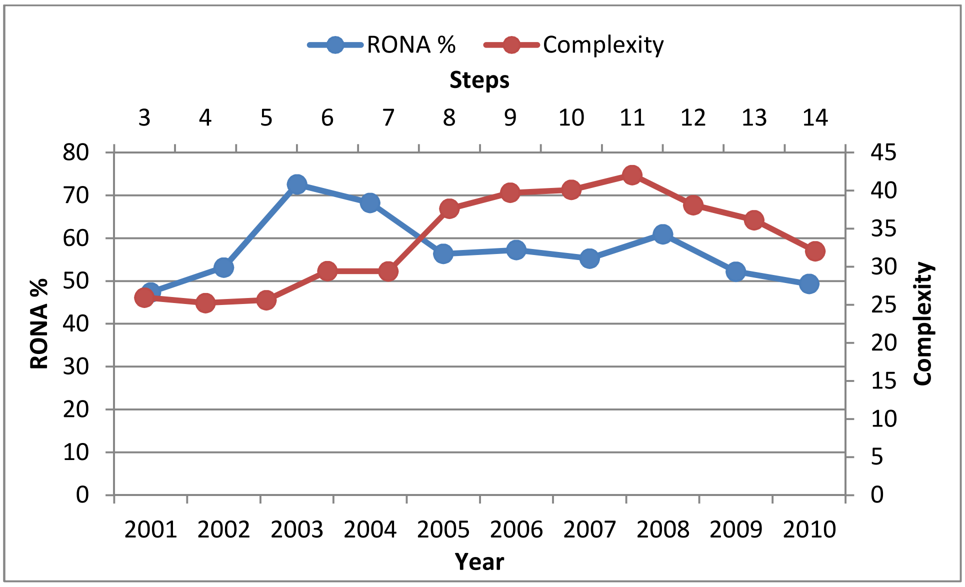


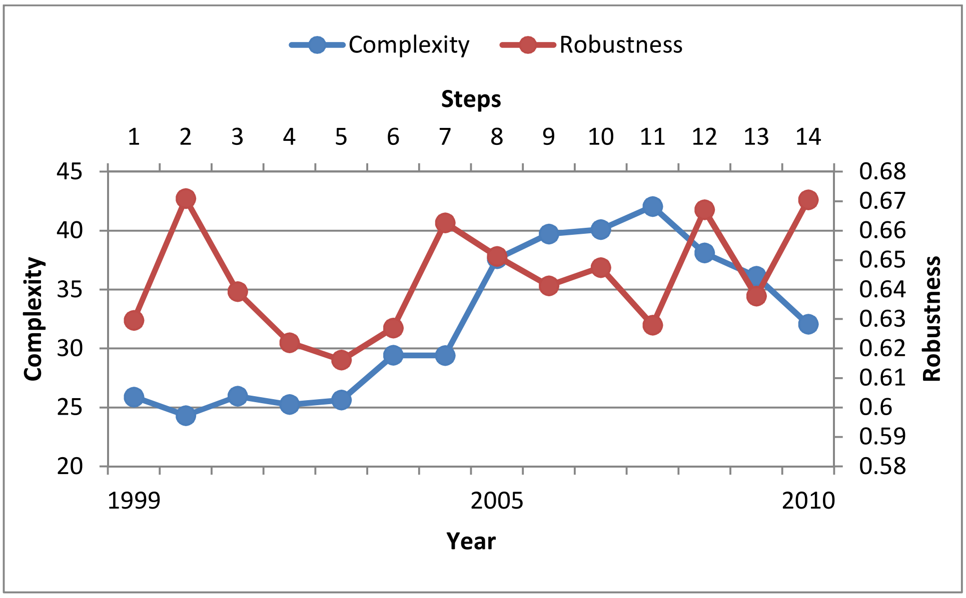
Figure 96 shows a clearer representation on the company's performance as seen in the figure when the complexity increased the RONA% started to drop. This is supported by Figure 93 where the complexity increased while the robustness started to slightly oscillate, showing that the company is slightly struggling with the complexity.

6.5.8 Paracon (PCN)

Paracon dynamic analysis was done with a widow size of 12 and overlap of 11, giving 14 steps. These 14 steps represents the 1999 to 2010 period that was studied of Paracon.

Figure 97 shows a stable complexity history with an overall increase of complexity over the years and a decrease in the complexity in the last few years. The figure also shows a fair and stable robustness history as indicated with a stability index of 80.72%.

Figure 97: Complexity and Robustness History of PCN



From Figure 98 a clear relationship is visible between the company's RONA% and entropy over the years. As the entropy or structure increased and decreased within the company the RONA% also increased and decreased.

Figure 98: RONA% and Entropy History of PCN

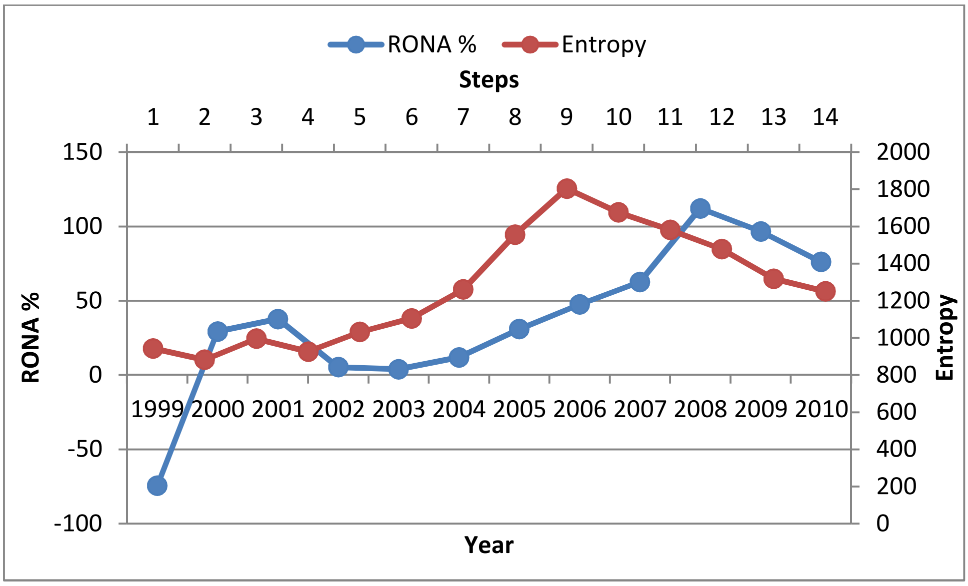


Figure 99: RONA and Complexity History of PCN

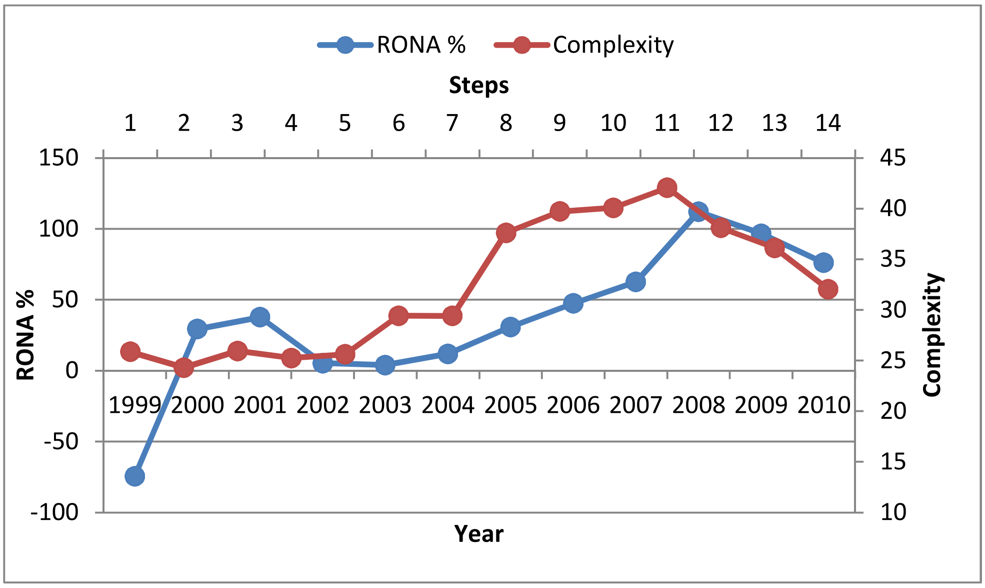


Figure 99 shows a clear relationship between the company's complexity history and RONA% history. The decrease in RONA% from the year 2000 to 2003 is supported by Figure 97 in step 2 to 5 where the complexity were stable and robustness was busy decreasing, which indicated that the company's ability to sustain uncertainty was decreasing and is reflected in the RONA% performance. From 2003 to 2008 an increase in RONA% is visible. This increase is supported by the increase in complexity and robustness in step 5 to 10. In the year 2008 to 2010 a decrease in RONA% is seen. This decrease is supported by step 11 to 14 in Figure 97 and Figure 98, where the complexity is decreasing, robustness starts to oscillate and the entropy that is decreasing which indicates that the structure is breaking.

6.5.9 Conclusion on Individual analysis.

The relationship between complexity and robustness is vital in the quest to increase a company's profit and is clearly seen in the individual analysis. Instances in the analysis are seen where the increase of complexity in combination with an increase of robustness led to an increase in RONA, but only to a certain extent. It is seen that as complexity continuously increase it starts to affect the RONA of the company in a negative way up to certain point. Thus showing similar signs on how Simplicity understands complexity, the view of good and bad complexity. However a higher complexity still means a higher fragility, it is clearly seen how complexity affected the fragility of the companies. At instances where the RONA suddenly dropped when complexity in the system reached its global maximum. This RONA crash is also clearly supported by the entropy figures where a sudden drop in entropy means a break in structure.

In conclusion, the company is placed in a good state of health when complexity is healthy and robustness is high, which creates the best opportunity for the company to increase profit.

7. Conclusion

Complexity is recognised as a property that greatly affects a company's profit, whether through increasing unnecessary cost, decreasing performance or influencing the fragility of IT companies. It is found that complexity has a direct impact on the company's state of health and this has a direct influence on the company's ability to increase its profit. From the consolidated analysis it is seen that RONA has a strong linear correlation with robustness and that an increase of robustness in the system by a mere 20% can increase the RONA% by 60%. From this analysis it is evident that complexity management is advantageous for companies by increasing profit and gaining a competitive edge in the market.

The Industrial Engineer is responsible for ensuring a sustainable business by balancing man, machine and money through business processes. Through increasing robustness not only company profit but also the sustainability of the company will be increased. This shows that complexity management satisfies the goal of an Industrial Engineer to make a system more sustainable with quantifiable value, thus introducing a different approach, complexity management, which can be of great value in business engineering for Industrial Engineers. Also when complexity is managed, it will ultimately lead to the reduction in the limiting constraints that made optimising difficult in the first place and consequently reopen the doors that have closed due to complexity.

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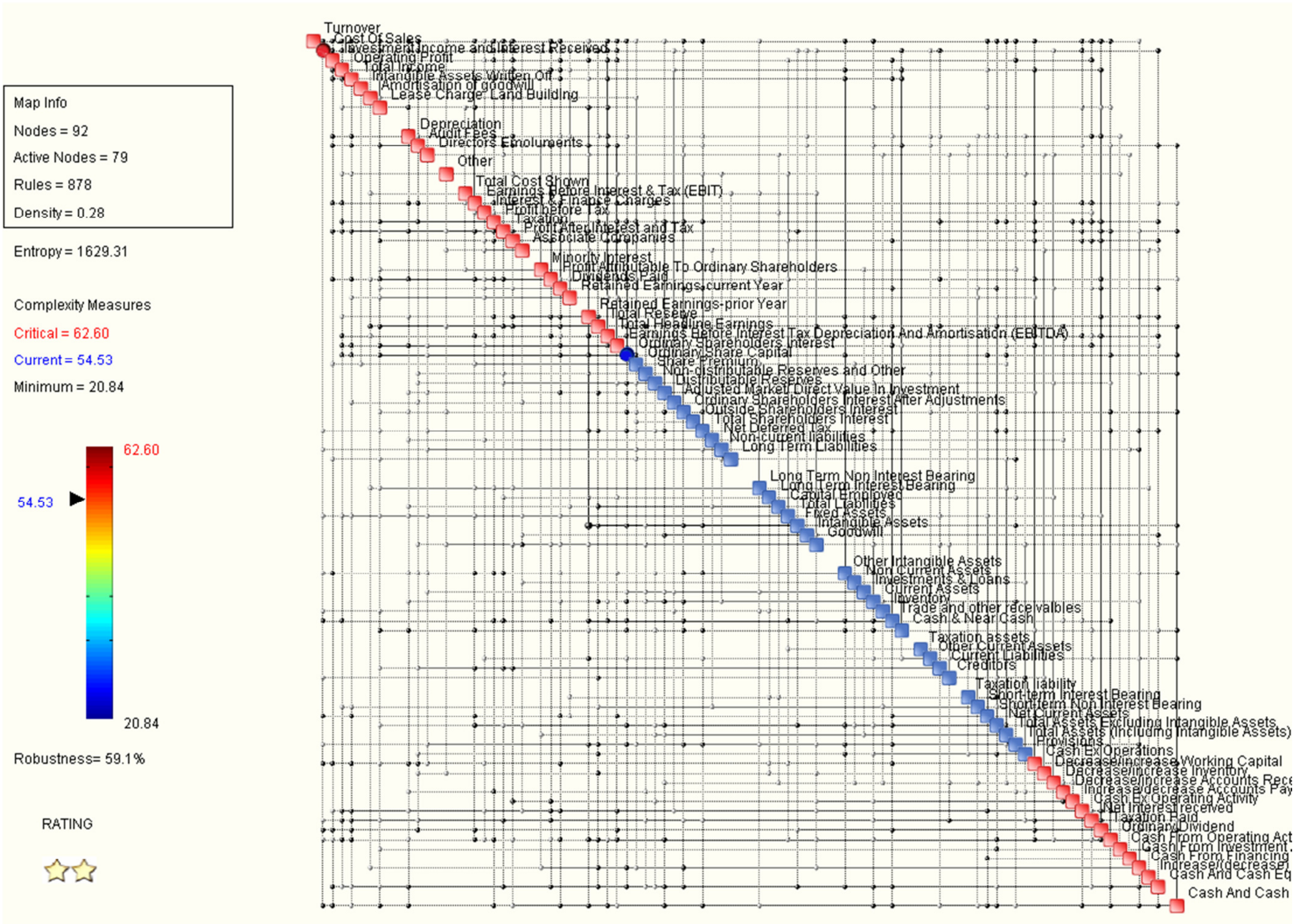
Appendixes

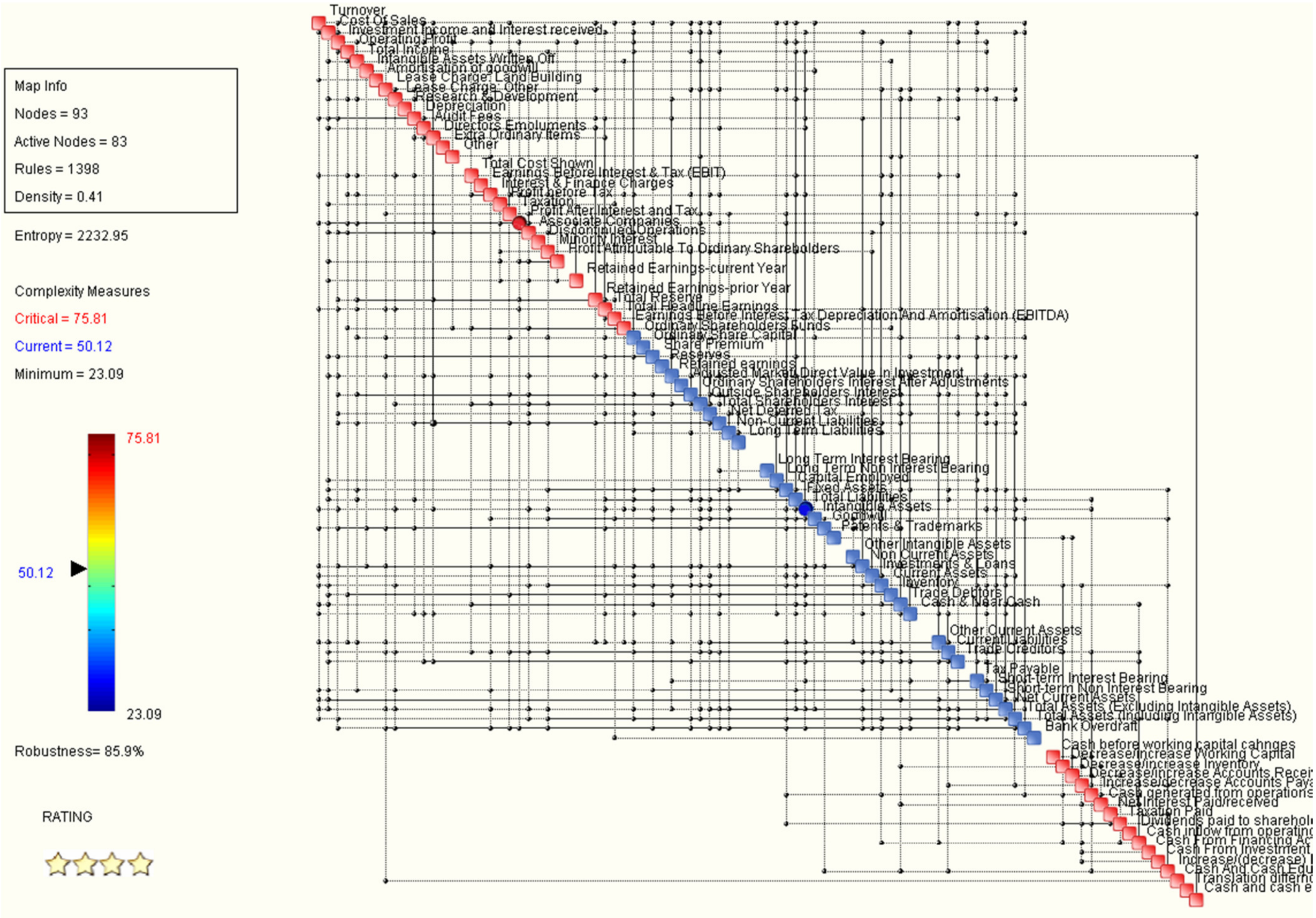
Appendix A: Complexity Maps (Static Analysis)

The complexity map is divided into three parts; red, blue and red again. The first red part represents the attributes from the income statements and where the second (blue) and third (red) represents the balance and cash flow sheets respectively.

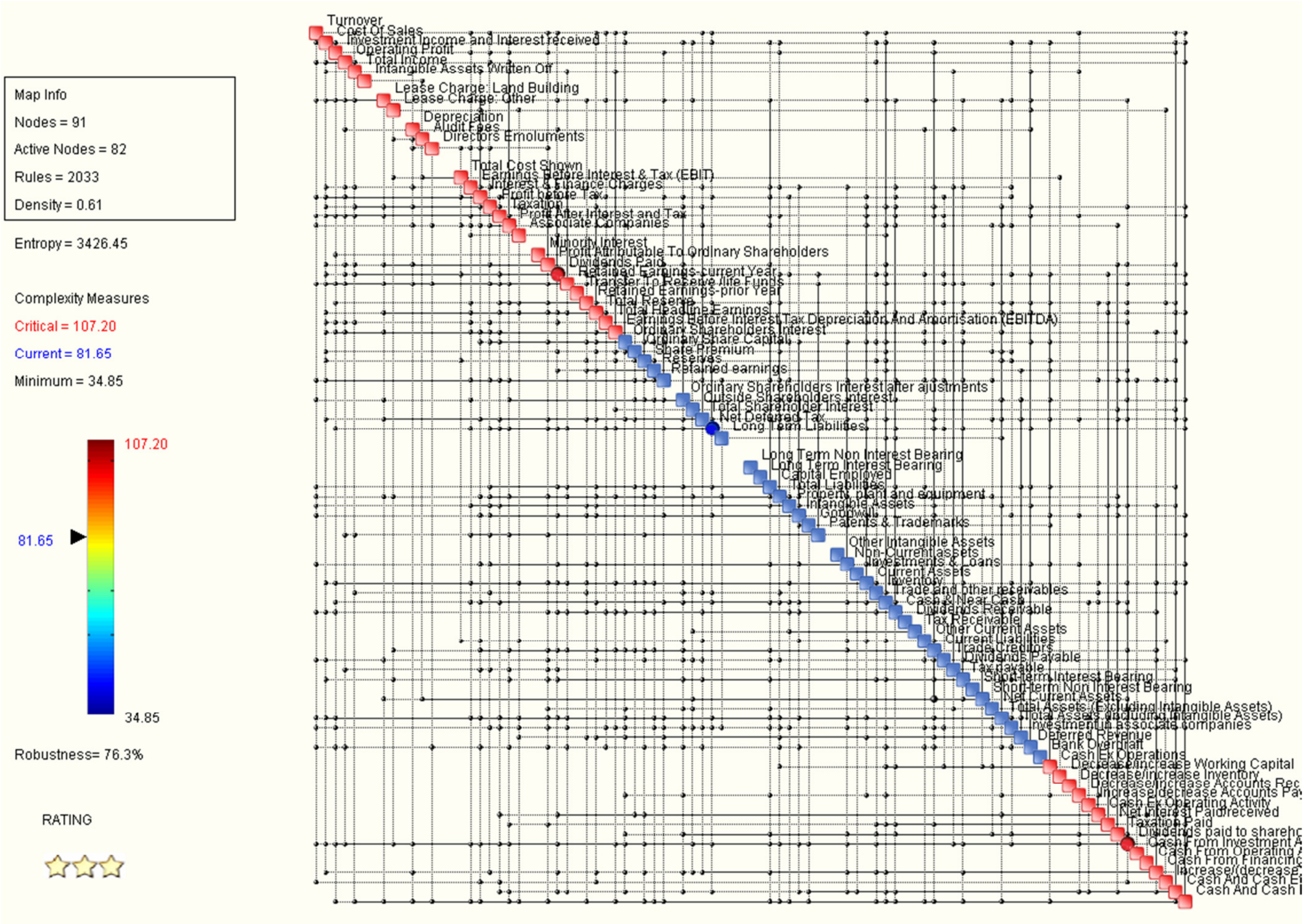
Datacentrix Complexity Map



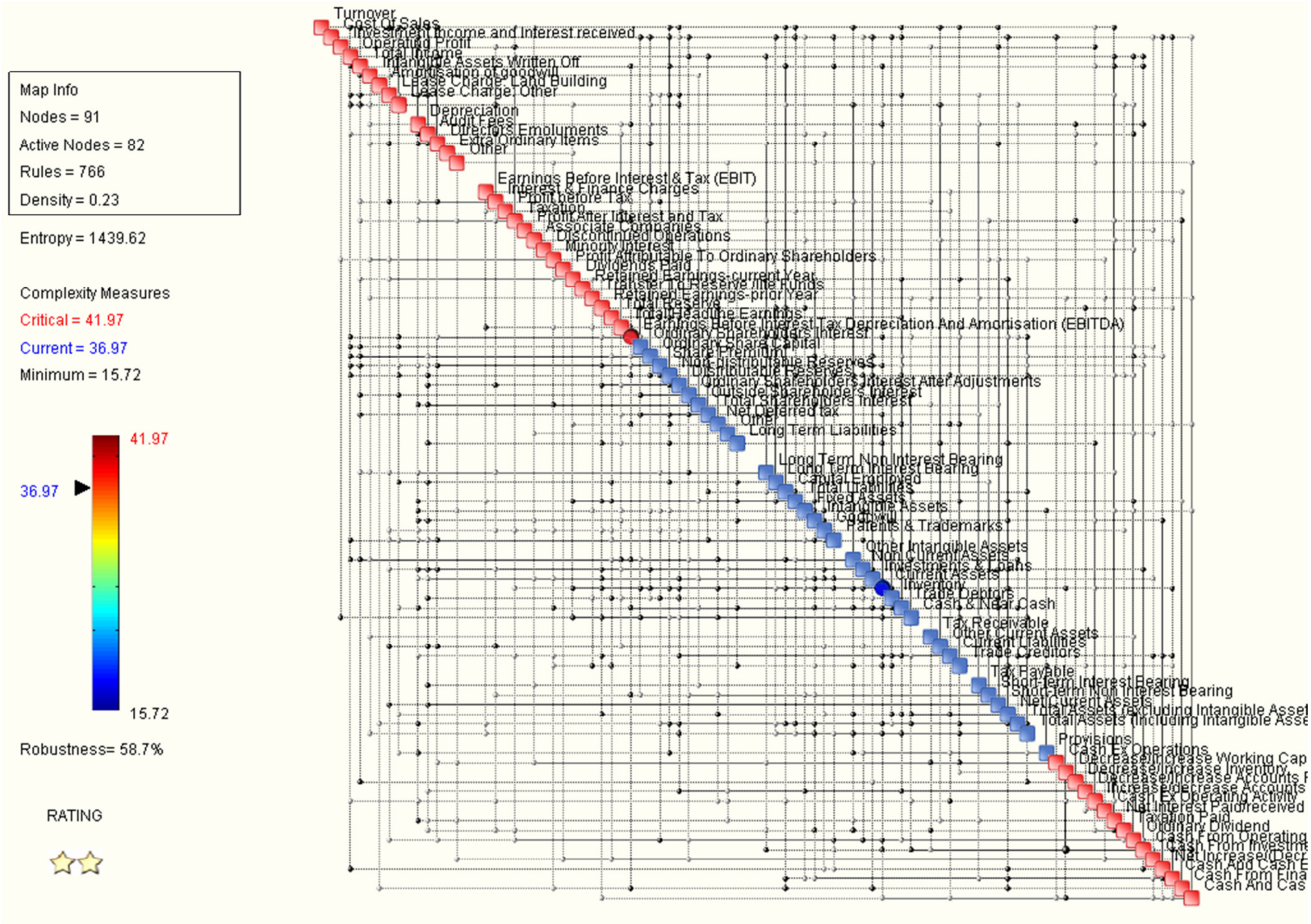
Datatec Compelxity Map



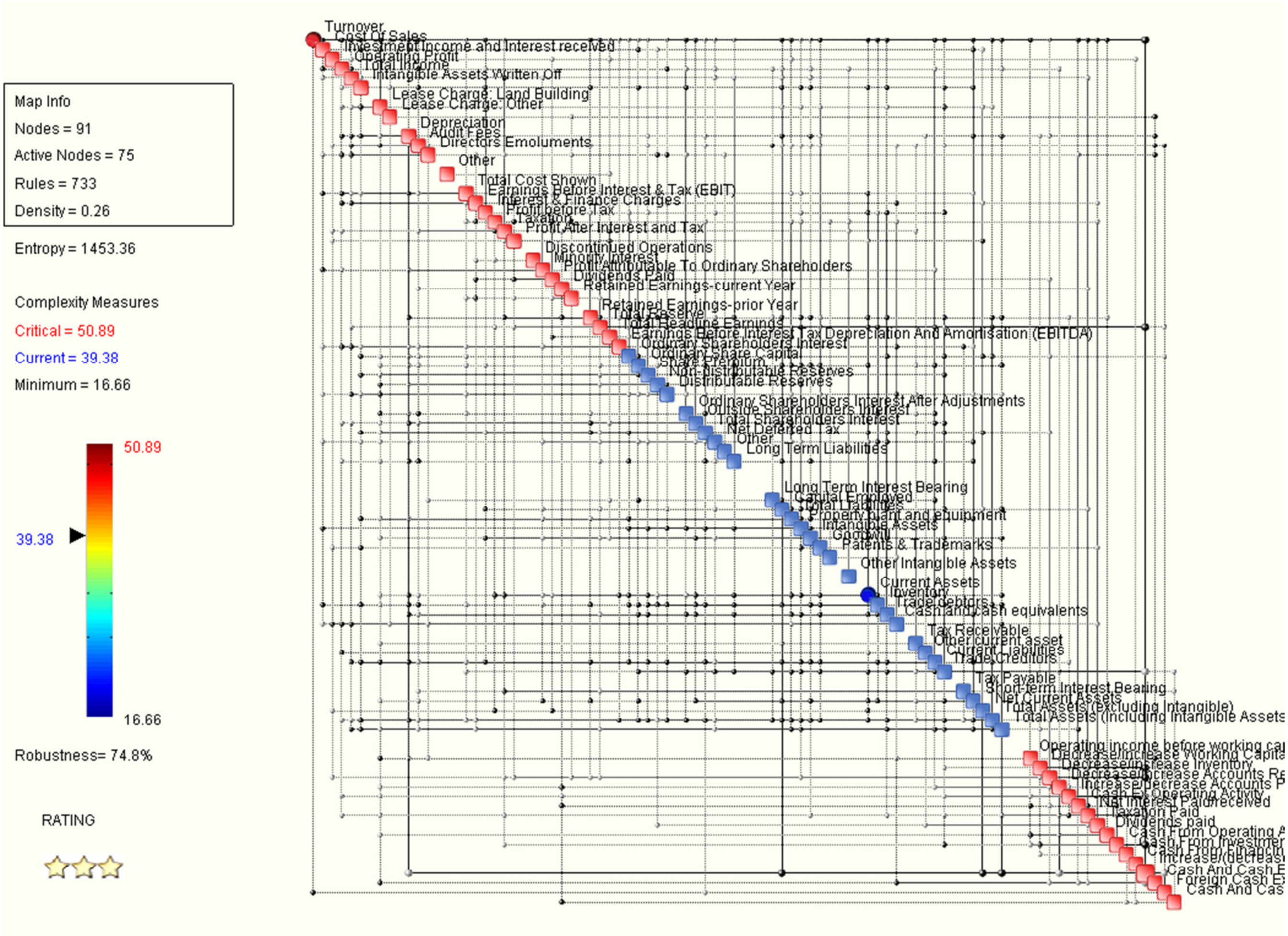
EOH Complexity Map



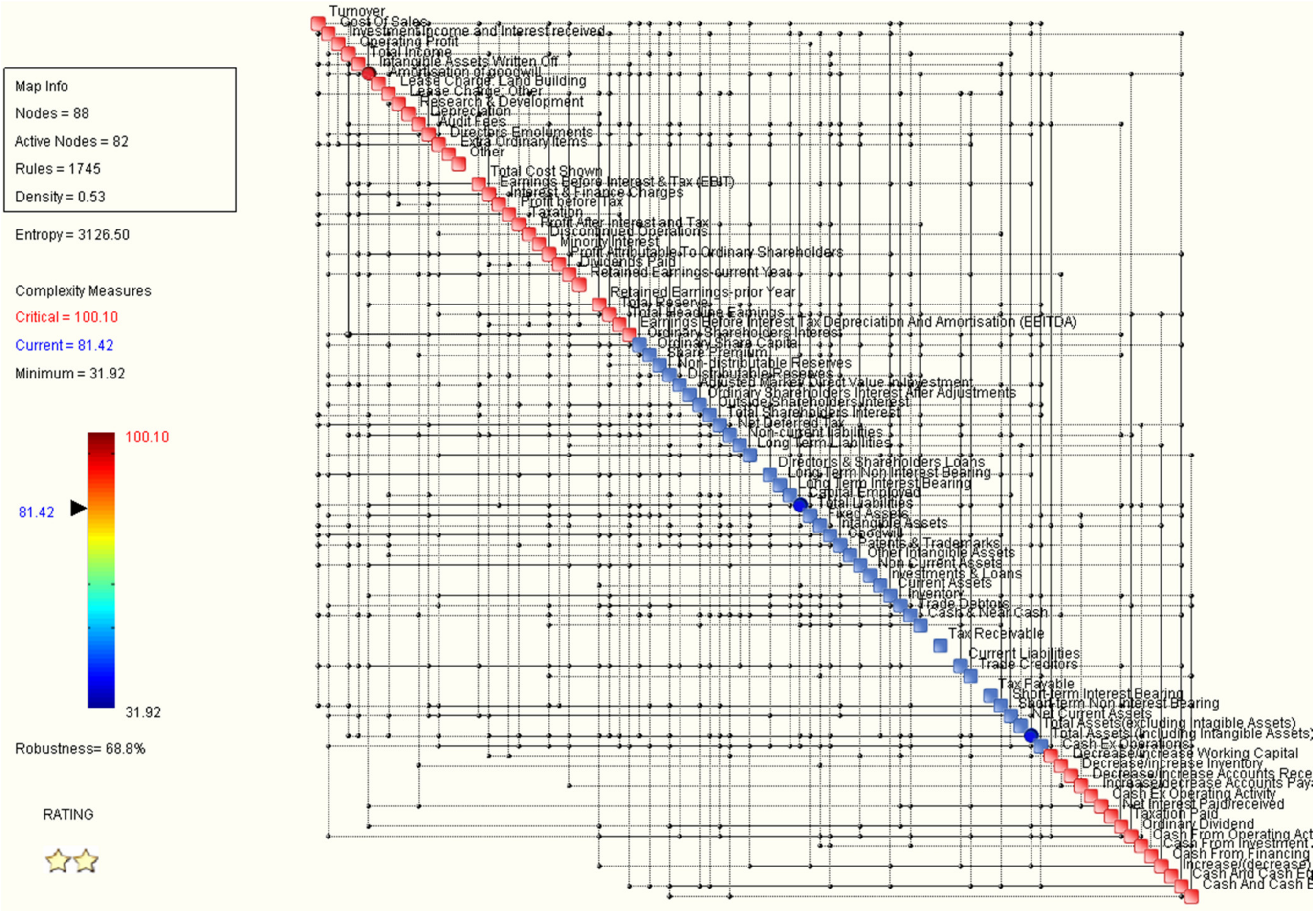
Gijima Complexity Map



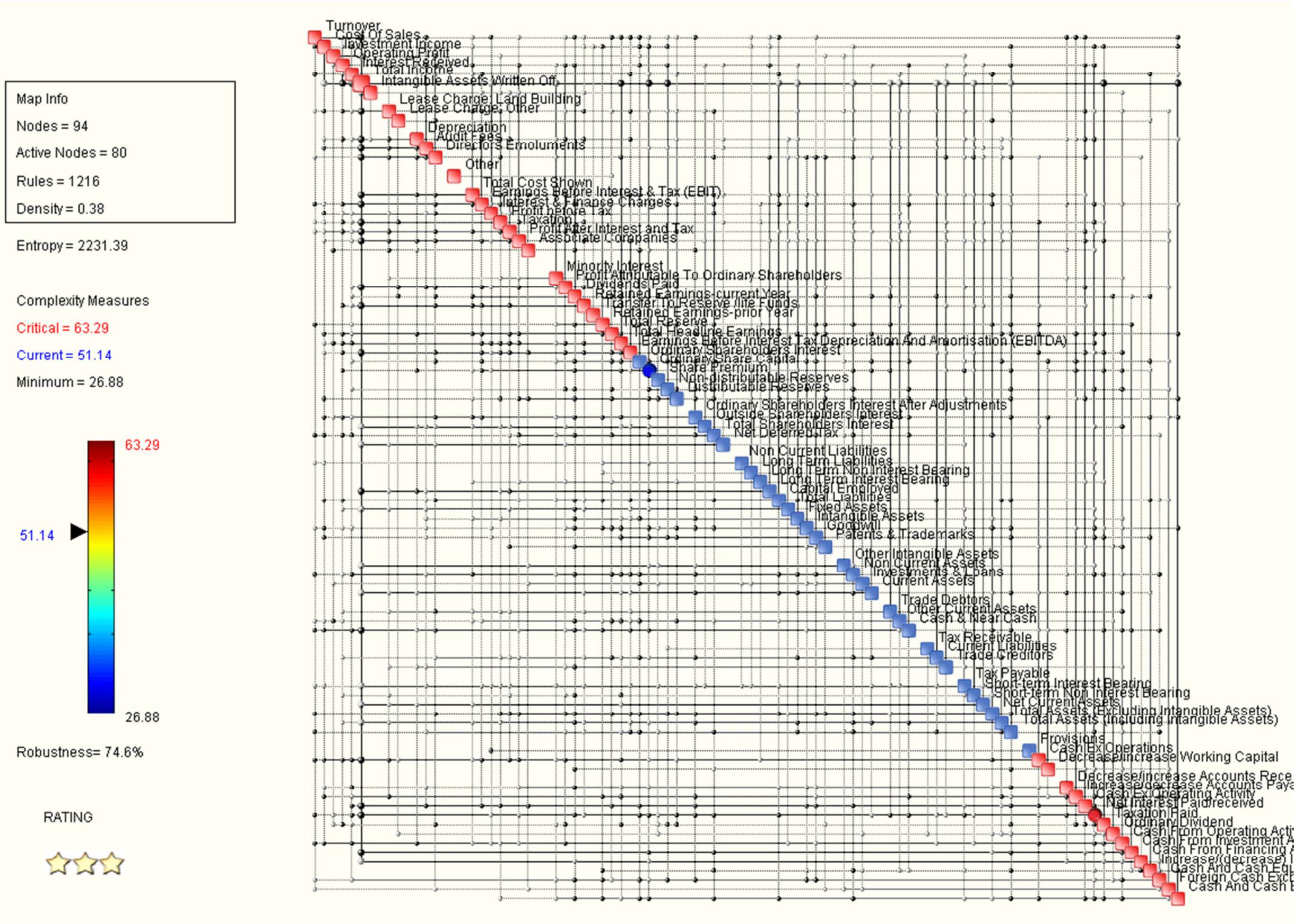
SecureData Complexity Map



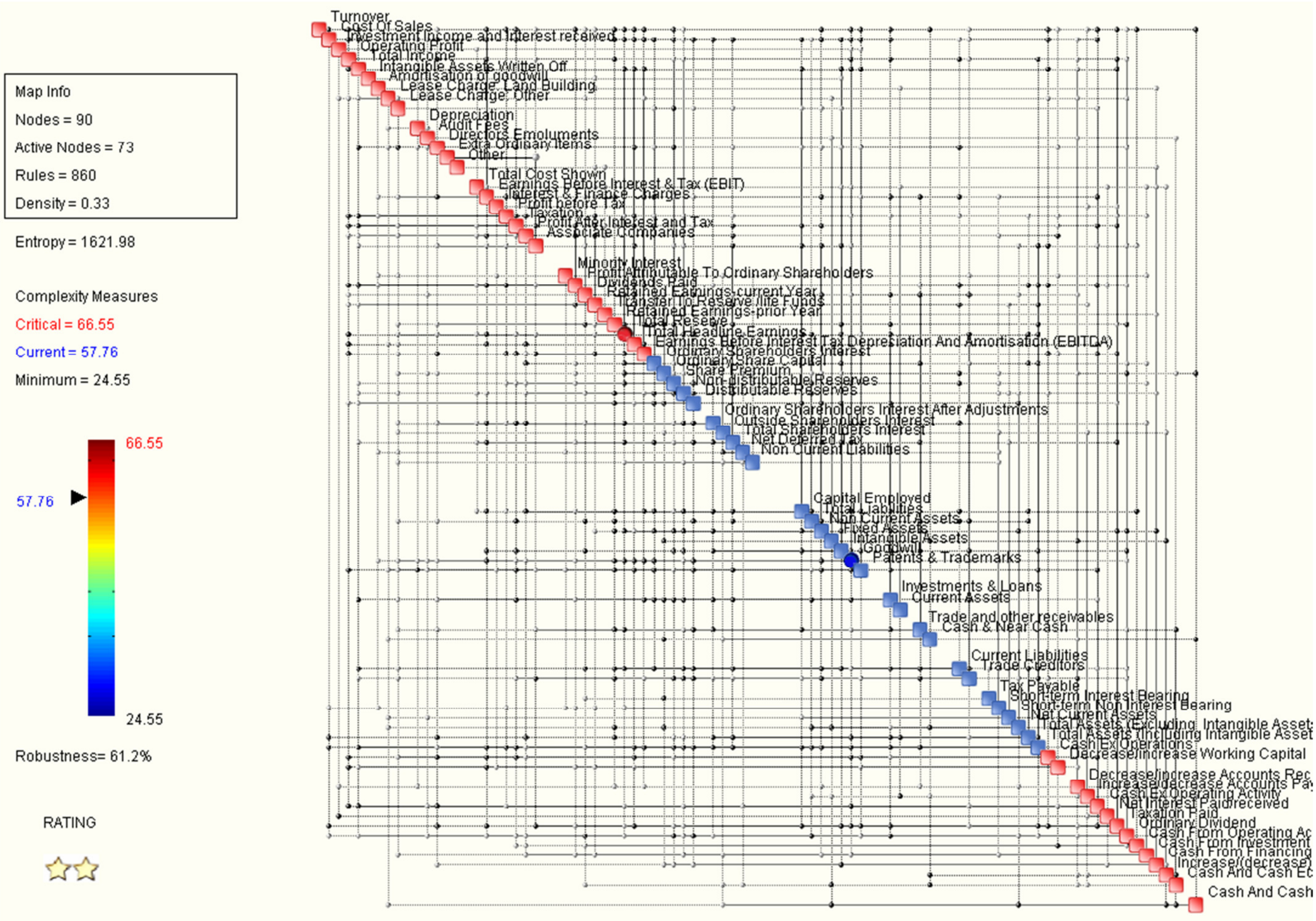
UCS Complexity Map



Adaptit Complexity Map



Paracon Complexity Map



Appendix B: Respective companies' RONA% values

The values (years) that are mark in red is the values that was identified as an irregularity among the data points and was classified as outliers in the data, and therefore excluded from the RONA% calculations. Outliers were identified by the 3sigma rule and observation.

Table 5: Paracon RONA% values

Year	RONA%
1999	-74.52
2000	29.35
2001	37.72
2002	5.31
2003	3.95
2004	11.87
2005	30.87
2006	47.45
2007	62.63
2008	112.1
2009	96.6
2010	76.11

Table 6: Adaptit RONA% values

Year	RONA%
1999	43.82
2000	-212.83
2001	47.35
2002	53.16
2003	72.57
2004	68.27
2005	56.35
2006	57.23
2007	55.26
2008	60.89
2009	52.21
2010	49.33

Table 7: EOH RONA% values

Year	RONA %
1999	-69.78
2000	32.26
2001	84.39
2002	70.94
2003	47.45
2004	31.95
2005	77
2006	83.32
2007	73.33
2008	71.1
2009	110.39
2010	200.97

Table 8: UCS RONA% values

Year	RONA %
1998	21.05
1999	37.76
2000	30.39
2001	32.28
2002	23.7
2003	30.07
2004	40.82
2005	53.38
2006	80.12
2007	157.23
2008	86.81
2009	33.91
2010	80.82

Table 9: SecureData RONA% values

Year	RONA %
2000	-510.74
2001	59.74
2002	55.96
2003	52.24
2004	61.41
2005	59.87
2006	79.41
2007	188.62
2008	74.04
2009	86.57
2010	94.31

Table 10: Datatec RONA% values

Year	RONA %
1995	23.4
1996	6.88
1997	22.35
1998	31.48
1999	-114.58
2000	-2.19
2001	57.09
2002	0.78
2003	-8.29
2004	-10.85
2005	17.3
2006	18.41
2007	24.03
2008	31.76
2009	31.32
2010	17.03

Table 11: Datacentrix RONA% values

Year	RONA %
1999	33.38
2000	39.97
2001	47.13
2002	34.67
2003	39.55
2004	27.71
2005	30.81
2006	31.01
2007	48.99
2008	55.11
2009	47.71
2010	29.58
2011	31.2

Table 12: Gijima RONA% values

1999	-1810.27
2000	-7.97
2001	-61.92
2002	-16.62
2003	0
2004	-161.08
2005	79.66
2006	32.84
2007	30.2
2008	43.85
2009	37.62
2010	34.88