University of the Witwatersrand

Faculty of Engineering & the Built Environment

School of Mechanical, Industrial & Aeronautical Engineering

Framework for a sustainable ERP license model in an increasingly competitive software market.

By

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A research report submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand, in fulfilment of the requirements for the degree of Master of Science in Engineering, under the supervision of Prof. I. Botef.

Johannesburg, July 2015

DECLARATION

I, Petrus Stephanus Gouws Botha (student no: 539947), am a student registered for the degree of Master of Science in Engineering in the academic year(s) 2013 - 2015.

I hereby declare the following:

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- I have followed the required conventions in referencing the thoughts and ideas of others.
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ABSTRACT

Enterprise Resource Planning (ERP) systems have notoriously complex license models.

Whilst the ERP market has been dominated since the 1980's by SAP AG and Oracle Corp., this picture is changing with these software giants slowly losing market share to the more than 100 proprietary ERP systems available today. Many of these new entrants wield simpler, more transparent licensing models.

This research aims to understand how the current ERP license models behave under varying market conditions with the goal of developing a "framework for a sustainable ERP license model in an increasingly competitive software market".

The research issues are addressed by modelling an actual economic firm with the aid of a software simulation. The aim of this simulation is to model how closely ERP license models link the benefit of the ERP to the cost of the license model.

Simpler license models (employed by the new ERP entrants) demonstrated a comparable level of cost/benefit.

The research concludes with a proposed framework for a sustainable ERP license model.

Potential future research includes investigating the use of gain-share or profit-share models for future software license models.

DEDICATION

This research is dedicated to my beautiful wife Lucille, who loves me in spite of my ambitions.

ACKNOWLEDGEMENTS

"We're still in the first minutes of the first day of the Internet revolution." – Scott Cook

I would like to acknowledge Prof. Ionel Botef for his valuable guidance, mentorship, motivation and sharing inspiring recollections of his own experience during this research.

With regard to general research methods and literature review, I would like to acknowledge Prof. Phil Botha and Prof. Annali Botha for their incredible support, guidance and altruistic assistance.

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF EQUATIONS

NOMENCLATURE

Term	Meaning
AMR	Advanced Market Research Corporation (currently owned by Gartner)
CIO	Chief Information Officer
COCOMO	Software costing model - refer to literature for a full description
Commoditisation	Concept introduced in Economic science, whereby a highly differentiated good, becomes undifferentiated. The effect is that a monopolist is challenged by competitors with identical products at lower prices.
Complimentary Assets	Products or services designed to be sold in combination with a core product to enhance customer value, but also extract additional revenue. An example is a printer and toner cartridges
Cost/Benefit	The trade-off or relationship between a cost and a benefit. The cost for a premium health insurance package is more, but the coverage or benefit is also greater
Cost/Saving	The relationship between the investment in and the return on a certain good. Buying a low energy bulb cost R100, but saves R1 for every ten hours it is used
CPI	Consumer Price Index - an index of annual price inflation determined by the central fiscal body of a country
ERP	Enterprise Resource Planning
ERP Cost	The cost (license cost and other) associated with implementing, operating and maintaining the ERP
ERP Implementation Partner	A professional services firm that specialises in implementing ERP systems for other companies. Other than installing desktop software, ERP system implementations require a deep understanding of technology, accounting, manufacturing, HR and other core business functions

ERP License Model	The legal agreements and pricing mechanisms by which it is determined how much a customer pays for the use of an ERP system.
ERP Partner	A professional services firm that specialises in implementing ERP systems for other companies. Other than installing desktop software, ERP system implementations require a deep understanding of technology, accounting, manufacturing, HR and other core business functions
ERP Saving	The saving in certain costs as a direct or indirect result of having an ERP system
ERP Vendor	A software firm that develops, sells and supports the ERP software. In some cases, the vendor may also act as an ERP implementation partner
EULA	End User License Agreement
Functional Developer	A position that develops/configures the ERP in a company that typically sells ERP systems (vendors or implementation partners).
Functional User	A position that interacts-with/uses the ERP in a company that is typically a customer of an ERP system.
Infor	Proprietary ERP vendor
Instrumental Value	Only possessing value if it is used to benefit some party. A hand calculator is made from cheap materials and has very little intrinsic value. Used by a person to perform math, it can save time and improve accuracy therefor having massive instrumental value
Intrinsic Value	Having value by virtue of its properties (i.e. without having to perform a function) such as gold or silver
IT	Information Technology
LE	Large Enterprise (Organisations with more than 500 employees)
License Mortality	The type/lifespan of license agreement: Perpetual, Subscription or Ad hoc (usage based)

Line of Business	Differentiation by types of industries such as Manufacturing, Petrochemical, Financial and Healthcare
Linear Regression	A statistical process to find a linear function that would describe a relationship between an input and output variable. This process also tests the accuracy (fit) of the linear function to the data
Marginal Cost	The change in cost to manufacture unit n+1 as opposed to manufacture unit n
Master Data	Single repository of definitions in ERP such as employee records and asset register
Reservation Price	The maximum price at which a potential consumer would be compelled to purchase the good or service. In other words, "willingness to pay"
Rotables	Rotating spares in a maintenance store. As reconditioned parts are installed the failed part is recycled as rotable
Sage	Proprietary ERP vendor
Scenario Planning	The discipline that uses interdisciplinary sciences (economics, politics etc.) to predict a set of possible future conditions rather than extrapolating current trends.
Scenario Run (Simulation)	Once a set of parameters have been entered to simulate an economic or internal condition, the 12 year historical data is processed through the model as if history repeats itself
SEER	Software costing model - refer to literature for a full description
SLIM	Software costing model - refer to literature for a full description
SME	Small to Medium Enterprises (Organisations with fewer than 500 employees)
Tier-1 ERP	One of the two leading ERP systems (SAP and Oracle)
Tier-1 ERP License Model	Technically complicated, multi-facet License agreement typically including: per-user, per-server, per-record, per-GB metrics in determining the final cost of license fees.

Tier-2 ERP	One of the well-known, smaller ERP systems such as Microsoft Dynamics.
Tier-2 ERP License Model	Less complicated license agreement. This typically only includes user licenses or server and user licenses.
Value	Actual or perceived benefit of using ERP system to the firm. In other words: "the reason to buy or to keep on paying for an ERP system"
Value Linkage	The link between the cost of a good or service and the amount of value that it delivers, especially when the cost changes. If one buys two units of product x, does it guarantee twice the benefit or only 20% additional benefit?
VBA	Adaptation of the Visual Basic programming language for use in Microsoft Office products
Zero demand price	In Neoclassical Economics, the price at which nobody would be willing to buy at least one unit of good or service

1 INTRODUCTION

The inability to properly valuate software was (in-part) to blame for the dot-com bubble. Only when the market became flooded with new dot-com entrants (in the early 2000's) was this over-valuation exposed and this led to a rapid collapse of internet stocks.

With the market capitalisation of the top ten software companies clipping $700 Billion in 2013 (Forbes, 2014), software is a massive industry-vertical by any measure. Considering that software license revenue remains the primary vehicle by which software companies generate income and subsequently the primary measure by which they are valuated, it is imperative that these license models are better understood in order to avoid a repeat of the dot-com bubble.

1.1 Background to the research

Enterprise Resource Planning (ERP) systems are generally regarded as one of the biggest investments that any modern organisation makes and are well known for their complicated software license models (Davenport, 1998).

These ERP license models have become so complex, that it takes a team of experienced ERP auditors days to determine exactly what the license cost should be for each ERP customer. Usually, this type of license audit needs to be conducted for each ERP customer at least once a year, or when there has been a major change to a customer's ERP system.

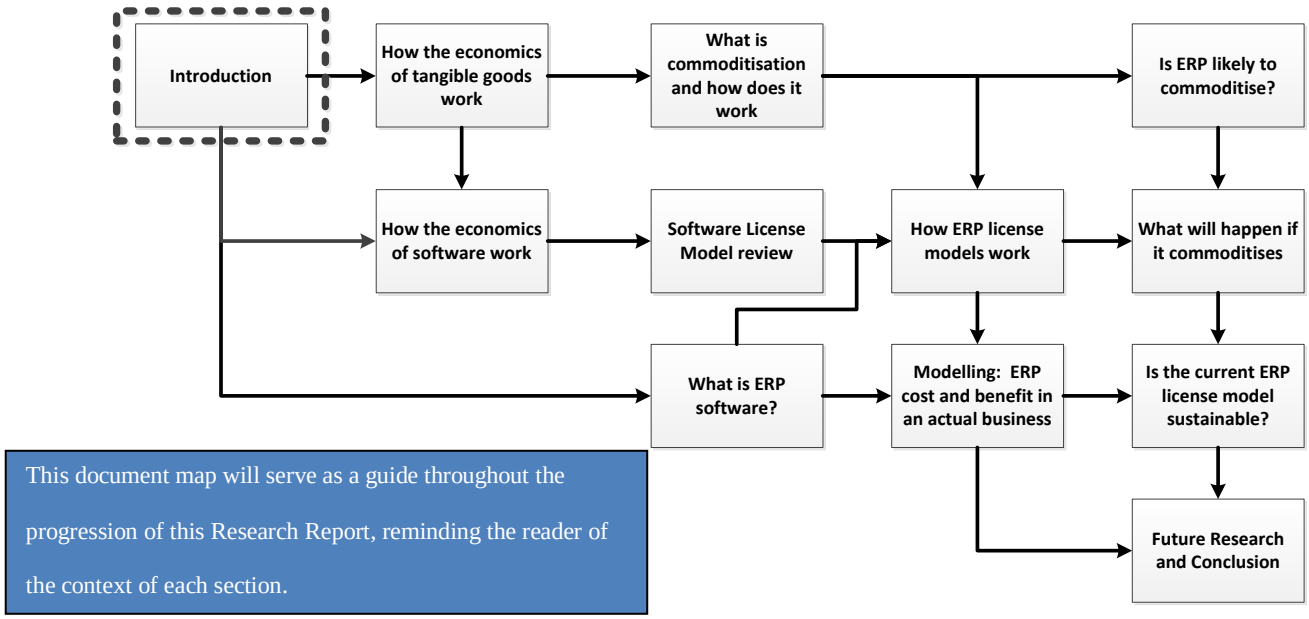

Figure 1: Document Map

Until recently, speculating about the necessity or efficacy of these license models would have been moot.

SAP and Oracle are known as Tier-1 ERP companies and their type of (complex) license model is generally referred to as a Tier-1 license model (Panorama, 2012).

Since the nineteen seventies, software giant SAP AG has dominated the Enterprise Resource Planning market that they essentially created (Herald, 2001). Closely in toe followed software giant Oracle Corporation. Thus, SAP and Oracle (who share similar license models) have always had the final say on license model complexity.

Recent studies by AMR (Gartner) and the Panorama Consulting Group support the view that SAP is slowly losing its light-year lead as more and more new entrants compete for the lion share of the ERP market (Panorama, 2012; Jacobson et al., 2007).

The new entrants (Tier-2 ERP Companies) are often ERP companies that have resisted acquisitions by SAP and Oracle (e.g. Infor and Sage) or have the backing of a larger parent company (Microsoft Dynamics) that would not allow acquisitions by the ERP giants.

These new kids on the block are (amongst other things) known for their simple, transparent licensing and pricing; known as Tier-2 license models (Microsoft, 2013).

The massive influx of new entrants into the ERP market, may be indicative of a market that is maturing with a technology (ERP) that is homogenising (Hofmann, 2008). This could see the ERP market ending up as a purely competitive market.

1.2 Justification for Research

The global ERP market in 2012 was worth more than $24 Billion (Columbus, 2013). That is more than the total Gross Domestic Product (GDP) of several African countries added together.

Whilst monetary policy (in even the smallest country) would enjoy considerable analysis and debate; from the literature it seems that very few scholars have actually tried to fully understand how ERP license models work (Lindley et al., 2008) and none (that could be found) have published work on how ERP license models behave under varying market conditions.

There has recently been uproar in the field of value engineering and value linkage: "Pay for something what it is worth" (Faulk et al., 2000). Whilst this "value" is very easy to determine for hard manufactured goods, it is not the same case with software such as ERP.

Software licenses cannot run out like gold or maize; and neither can it be traded or eaten. What this aims to convey is that software has no intrinsic value and that it plays by very different economic rules than brick and mortar manufactured goods.

Undisciplined

This research will use a multi-disciplinary approach to answering the research questions.

The reason for this is that the research questions themselves are rooted in a grey area overshadowed by:

- Software Engineering
- Complex Systems Theory
- Microeconomics
- Value Engineering
- Statistics
- Systems Engineering

By embracing all of these facets the research will be able to provide the most holistic insight and future direction.

Whilst software has become and remains an indispensable part of how business is conducted in the 21st century, the dot-com bubble has shown that mankind's grasp of software's true value, is tenuous at best (Ljungqvist & Wilhelm, 2003).

The justification for this research is rooted in the multi-disciplinary approach that this research proposes to pursue in trying to answer the research question.

As will be shown, pricing of (ERP) software under monopolistic conditions may be complex, but it remains simple compared to the process of pricing software under purely competitive market conditions.

In a monopolistic market, forces such as network effects, brand and Price Discrimination play a massive role in determining the price equilibrium (Lehmann & Buxmann, 2009). In a purely competitive market, instrumental value and utility take over this role of price determinants (Dewan et al., 2000). Until we understand exactly what these are and how they are linked to the license model, the framework for setting up a sustainable license model (under purely competitive markets) will remain a guessing game.

Understanding this framework is important both from an economic-firm as well as from a software engineering perspective, since licensing directly determines the revenue of ERP firms (Lehmann & Buxmann, 2009) and revenue in turn determines the investment in R&D, new features and future direction of ERP (Choudhary, 2007).

1.3 Research Problem

The market for Enterprise Resource Planning software is massive and growing. The current two major incumbents have developed the market that exists today and as a result they have shaped the complex licensing models that are predominantly in use.

This market is changing day by day with new entrants entering the market. These new entrants seem resistant to aligning their license models with the current incumbents and instead present much simpler, more transparent licensing models.

The mechanics of a licensing model affect much more than just the text on a licensing invoice; it affects the way in which a customer chooses and uses software as well as how the vendors develop, market, sell, and deploy the software.

The current incumbents have always defended their license models' complexity by claiming that the complexity of the license model helps to align the cost of the software to the value that the customer gains from the software.

The very being of the current (complex) ERP license models are under threat and this research should address the problem of determining a "Framework for a sustainable ERP license model in an increasingly competitive software market".

1.4 Aims and Delimitation of Scope

The research report proposes developing a framework on how to design a sustainable license model for Enterprise Resource Planning (ERP) software. This research report aims to:

a) Assess (by computer simulation) whether the licensing revenue charged by ERP vendors is linked to the business value that the customer firm realises from the use of the ERP.
b) Gauge whether the existing ERP market will become more/purely competitive in years to come.
c) Investigate whether the current license models and licensing strategies employed by market leaders in ERP software will be sustainable in the increasingly competitive ERP market.
d) Assemble a theoretical framework within which a sustainable license model can be developed for ERP software in the future.

Considering the aims of the research, the following limitations will apply:

a) It is accepted that based on cited literature and previously conducted surveys that the ERP market is currently undergoing commoditisation.
b) The software simulation aims to model a simple business where the interaction of an ERP is clear and demonstrable; therefore some non-critical business processes will be omitted.
c) The scope of the software simulation will be limited to simulating only one business. Whilst it is accepted that an ERP will behave slightly differently in different types of enterprises, it is assumed that it will not be fundamentally different.

d) Although open source software poses a possible threat to proprietary ERP software, it is assumed to not yet be at a stage where the significance of open source has to be considered in this study.
e) Penetration pricing, random discount and other market entry strategies are excluded from consideration of the license model analysis and simulation as it is assumed that ERP customers have a finite switching cost and that penetration pricing does not represent the steady state licensing scheme employed by ERP vendors.
f) Based on cited literature, it is assumed that the concept of ERP as a technology is mature. Therefore, although sporadic disruptive innovations on the delivery method or infrastructure do occur, these will not be considered as sustainable competitive advantage drivers for any ERP vendor.

1.5 Research Question and Hypothesis

In addressing the research problem, the researcher posed the following research question that will assist in identifying a framework for a sustainable ERP license model:

- "Is the total license cost linked to the value that customers are getting from ERP?"

This research question is tested by using the following hypothesis:

- The total cost of Tier-1 ERP licenses is not linked to the total saving (direct and indirect) that ERP yields

The research question and hypothesis is explained in-depth in Chapter 2.

1.6 Source of Data and Methodologies

This research will use a multi-disciplinary approach to answering the research questions.

The reason for this is that the research questions themselves are rooted in a grey area overshadowed by:

- Software Engineering
- Complex Systems Theory
- Microeconomics
- Value Engineering

- Statistics
- Systems Engineering

Whilst it is clear which disciplines within engineering can be used to address the research questions, there is very little prior research on the testing of software license sustainability or the development of frameworks for software licensing.

The research paper will start with a literature survey of the available information in order to understand the context and set the scene. Following this, a computer simulation will be used to test the hypothesis.

The data from the computer simulation will be analysed using accepted methodologies and statistics.

This analysis will finally be explored in terms of its implications for the hypothesis and final conclusions will be drawn.

1.7 Contributions

The contributions to this research paper can easily be split into the following three categories:

- Literature Research
- Exploratory Research
- Interpretation

In the diagram below, the different document sections that will be used in this research paper have been grouped into containers that show the classification of each.

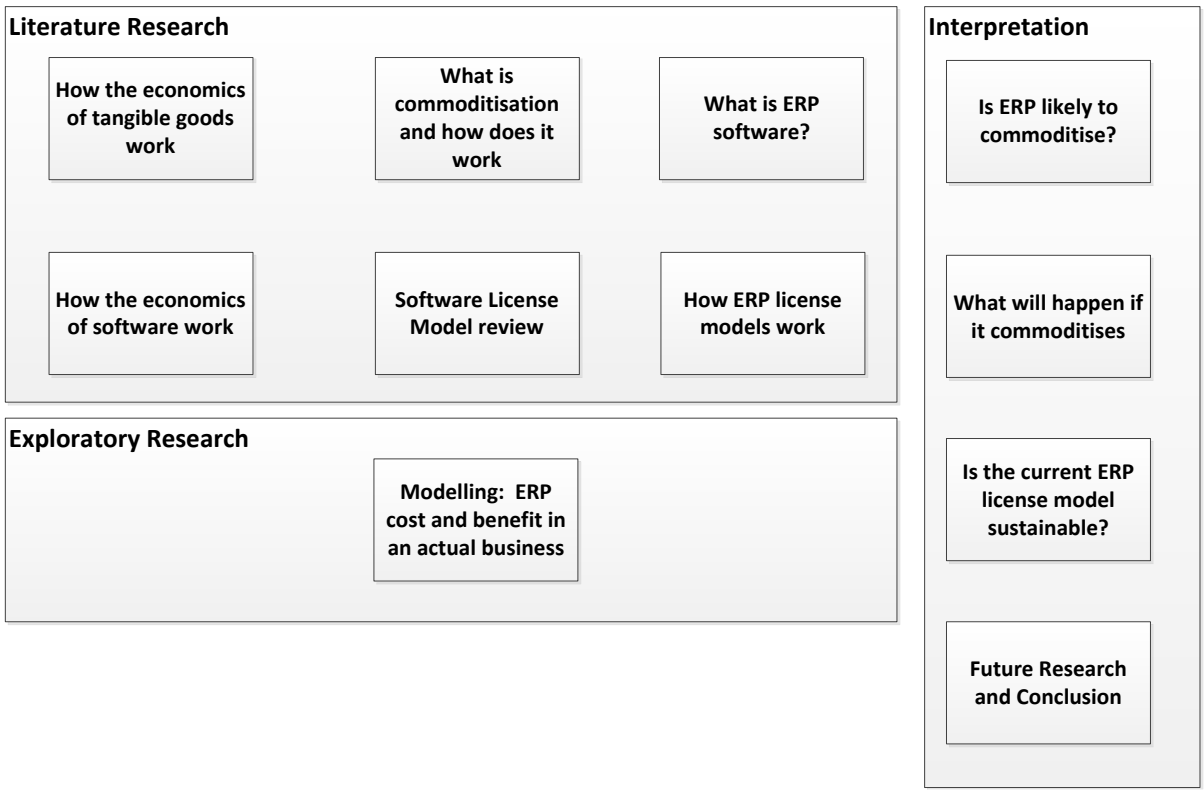

Figure 2: Classification of Contributions

1.8 Definitions

This section serves to provide some key definitions of concepts from the body of literature relevant to this research.

1.8.1 Enterprise Resource Planning

Enterprise resource planning (ERP) is the term that was coined by Gartner (Herald, 2001) in the nineteen nineties to describe the breed of business software that uses a centralised data store to facilitate all key functions of an enterprise (Johansson & Sudzina, 2008) such as

- Accounting
- Human Resources
- Production Planning
- Sales and Distribution
- Etc.

The concept has expanded in recent years to include non-core business functions such as Plant Maintenance, Customer Relationship Management and Business Intelligence.

1.8.2 End User License Agreement

The term “Software License” is a shorthand name for the contractual agreement between a customer of software and a vendor of software. This is also known as an End-User License Agreement.

An End-User License Agreement (or EULA) serves two very important functions:

1. It serves as the legal contract between the software vendor and customer on how the software will be used and how the vendor will support the end-user when using the software in a compliant fashion
2. It is the primary mechanism that determines how a software vendor’s income is generated

1.9 Outline of the Research Report

The Research Report has been split into five main chapters. The following diagram provides a breakdown of which document sections are contained in which of the five chapters.

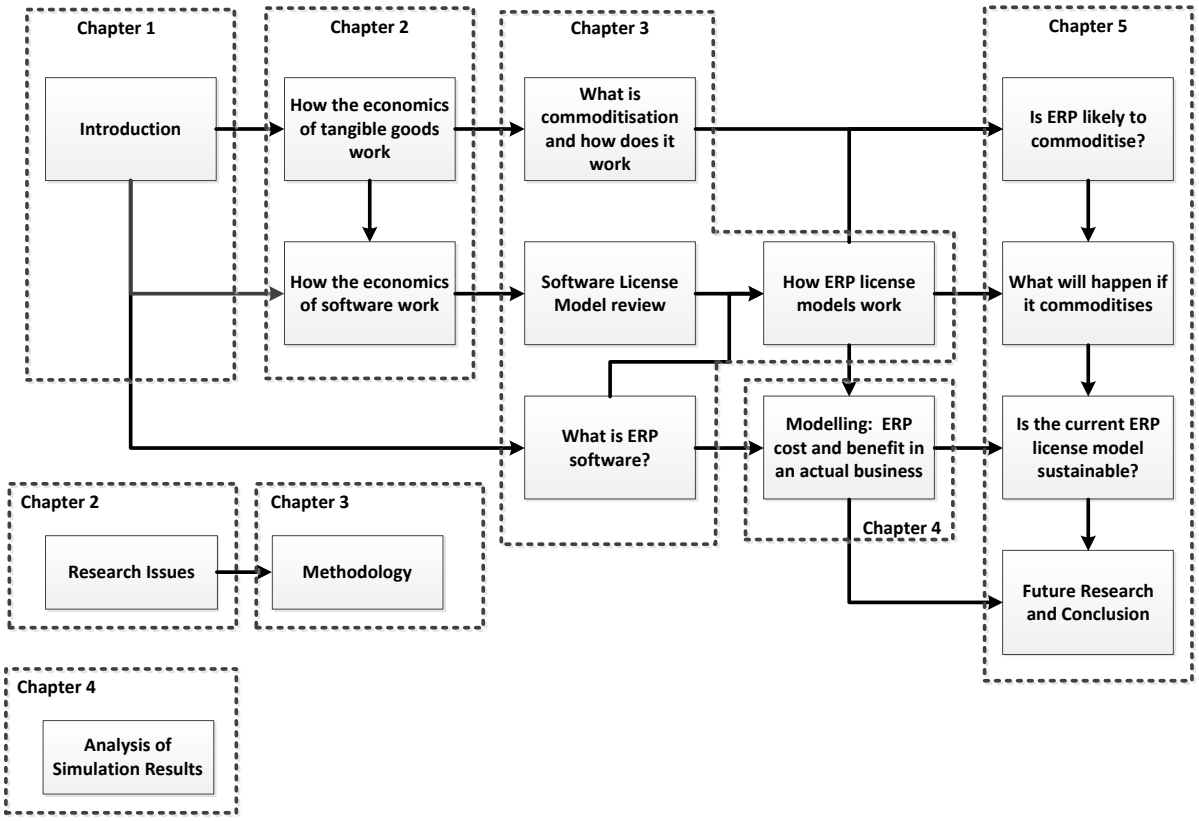

Figure 3: Research Report Structure

Each chapter starts with an introductory section that assists in positioning the purpose of the chapter as well as the flow of the sections contained in the chapter.

Finally each chapter contains a conclusion that assists in binding together the content of the chapter and assisting the transition into the next chapter

1.10 Conclusions

This (Introductory) chapter was intended to provide the basis for this research paper as well as indicating the structure and the outline of this research paper.

In the process of positioning the research issues, the next chapter will first explore other concepts such as the economics of software and compare it to the economics of "brick and mortar" manufactured goods. The chapter will also provide relevant definitions for ERP software and the concept of "commoditisation" in the context of this research.

2 RESEARCH ISSUES

2.1 Introductions

This chapter is aimed at identifying the relevant research issues relating to the research problem. In discussing the research issues, it is first necessary to understand how software departs from the Neoclassical Economic model of manufactured goods.

2.2 Software as a "manufactured good"

The Neoclassical Economics of supply and demand illustrate that there are a range of different markets that a manufactured good can find itself in, with the two extremes of market conditions being a monopolistic market and at the other end a purely competitive market (Jain, 2006).

In order to understand how software is priced/valued one has to relate the software to the type of economic market that it belongs to.

In Neoclassical Economics, the different types of markets have all been modelled on goods with similar economic "traits" (e.g. marginal cost and total average cost). Whilst software shares some of these "traits" and is sold as a "manufactured good", in some other respects it departs from this model altogether (Viswanathan & Anandalingam, 2005).

This section aims to explain the "economics of software" along the context of Neoclassical Economic guidelines and principles. It will show where software's economic behaviour departs from the rules of the traditional microeconomic model. This is a key building block in support of the argument that software is not bound by "scarcity of supply" or "intrinsic value" pricing.

2.2.1 Introduction to "the economics of tangible goods"

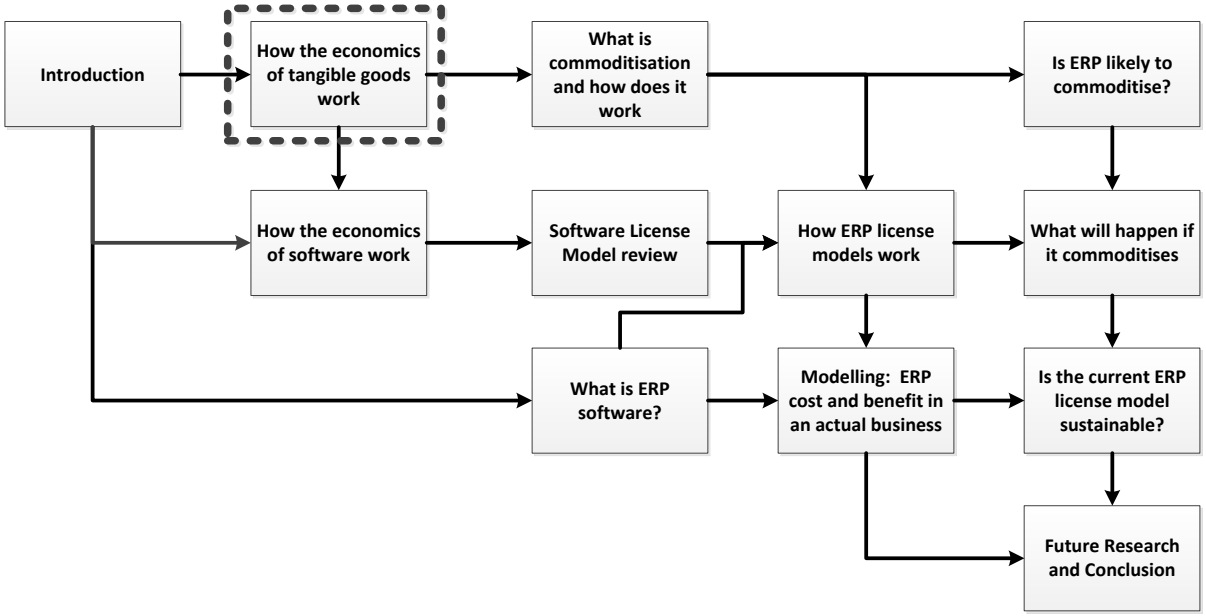

Figure 4: Document Map

Neoclassical Economics explain the price at which any manufactured good would settle as a function of supply and demand. The supply is governed by the supplier(s) and the demand is governed by the market consuming the good or service (Jain, 2006).

As can be seen in Figure 5, the intersect of the supply (S) and Demand (D1) curves, determine the price (P1) at which the market is willing to consume the product.

If the market shifts their demand from D1 to D2 (without the supply increasing), this moves the quantity required from Q1 to Q2. The supply curve determines that the acceptable price at which the market will consume the product then moves from P1 to P2.

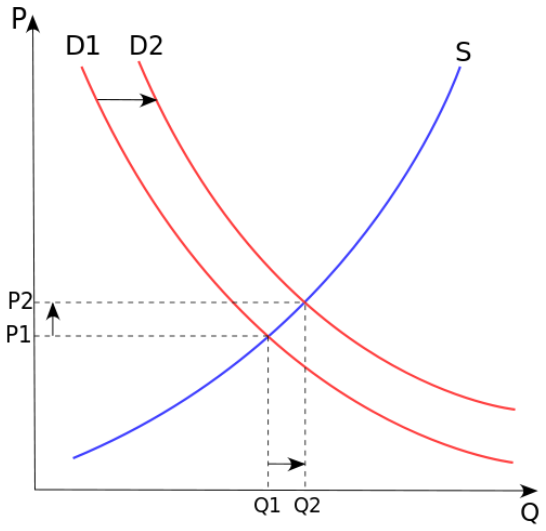

Figure 5: Neoclassical Supply and Demand model

In the same way, if the demand remains static and the supply should decrease (the S-curve shifts left), the price would also settle at a higher point since there is the same amount of buyers now competing for fewer products (Jain, 2006).

This general mechanism holds for monopolistic as well as purely competitive markets, however in a (non-colluding) purely competitive market it is impossible for all the suppliers to artificially force down supply (Jain, 2006).

What this means is that in a monopolistic market, the suppliers "get to decide" on the price at which it sells a product and is thus generally referred to as a "price maker". In a purely competitive market, competitors will continue to undercut each other until the price settles at a minimum where only the most efficient incumbents can survive (on very low margins) and these incumbents are thus referred to as "price takers".

In actual fact, monopolies cannot set their prices to whatever they like. The maximum that a monopoly can charge for a product is the "perceived value".

If a monopolistic aircraft manufacturer sells a commercial aircraft to an airline operator at a huge profit, however significantly less than it would cost the airline operator to develop their own aircraft; they would be willing to buy it.

Conversely, commodities are sold at their intrinsic value. Maize (and other commodities) is easy to manufacture (relative to aircraft) and the seller thus has to settle for a price very close to the cost of manufacturing the good.

2.2.2 Economics of Software

In a sense, software is also a manufactured good. It goes through the same stages of: Feasibility, "Research and Development" and Commercialisation. However, when it comes to the production stage, things are much simpler.

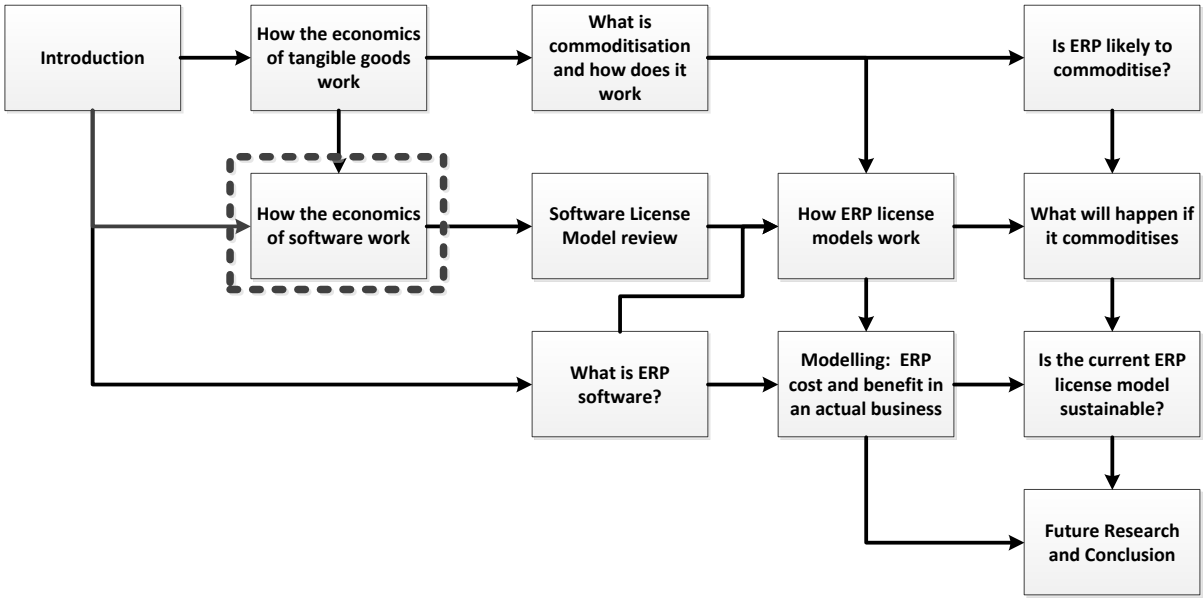

Figure 6: Document Map

At the point in time where software was still exclusively sold on Compact Disc (packaged in a luxuriously printed box), there were still aspects of production and supply chain logistics involved. More recently almost all software purchases are conducted as an electronic transaction without any exchange of physical goods. The software is usually then downloaded by the new owner. This paradigm shift allows billions of these "manufactured goods" to be sold out of a garage-based software firm in rural Africa.

This means that software is not bound by the economic laws of supply and demand. In economic terms: software has very little variable cost and no marginal cost (Church and Gandal, 1992).

In the Economics of "brick and mortar" manufactured goods, Marginal Cost is the killer of any runaway success product.

Even if a manufacturer could find a market to consume an infinite number of its goods, ballooning marginal cost would see the last (infinity + 1) unit costing an infinite amount.

However, this is not the case with software. The last (infinity + 1) unit will cost the same to manufacture as the unit before that, namely zero (if one assumes the fixed cost of development to be a sunk cost).

There are researchers and analysts that are of the view that software has a non-zero marginal cost.

Their argument goes towards providing customer support for the masses would definitely be more expensive than for the few.

In this research, customer support has been divorced from the cost of selling the software, since this research deals with enterprise software that uses annuity-based support agreements.

This (near zero variable cost and zero marginal cost) exposes a second, very powerful mechanism that software manufacturers use to sell more copies, namely: Price Discrimination.

Price Discrimination refers to the mechanism that firms use to exploit consumer surplus by selling goods to different consumers based on their requirements or ability to pay (Varian, 1995). An example might be a publisher selling textbooks at a discounted price in 3rd world countries or another example would be a grocery store offering volume-discount to customers buying many units of a product.

The reason that Price Discrimination is so important to the manufacturers of software is due to the fact that no market consists exclusively of a single group willing (or being able) to spend the same amount on software. It is actually made up of many groups respectively willing (or being able) to spend at different levels for the same piece of software (Dewan et al., 2003). This means that if the software is

sold at price "x", the software vendor is missing out on many consumers that are willing to spend only slightly less. In addition to this, software vendors are not bound by the concept of a minimum price that manufacturers of hard goods cannot avoid (Dewan et al., 2003).

This explanation creates a unique challenge for software in a commoditised market since (effectively) it holds no intrinsic value. Although there is an upfront cost associated with developing software, this becomes zero when spread across an infinite number of software copies.

2.2.2.1 Software Costing Models and Profit Maximisation

The previous section evokes the question of how a software vendor sets an (initial/average) price for its software licenses.

It is said that the first copy of Windows Vista cost $10 billion and every copy thereafter nothing; however by charging nothing for the first copy and $50 for each copy thereafter they were able to make a decent profit from the first copy (Seattletimes.com, 2014).

Despite this humorous analogy, software costing models seems to have been a pseudo-science since its inception. There has never been convergence on one software costing model as the dominant one and the relevant literature is littered with the remains of each previous software costing model being obliterated by the next.

These software costing models (always sporting a catchy name such as COCOMO, SLIM or SEER) are all in essence very specialised "project lifecycle costing" frameworks that may (at best) predict the cost that will be incurred in developing a piece of software or a system. This does not start to address the issues of value, demand or "willingness to pay".

2.3 What is ERP software?

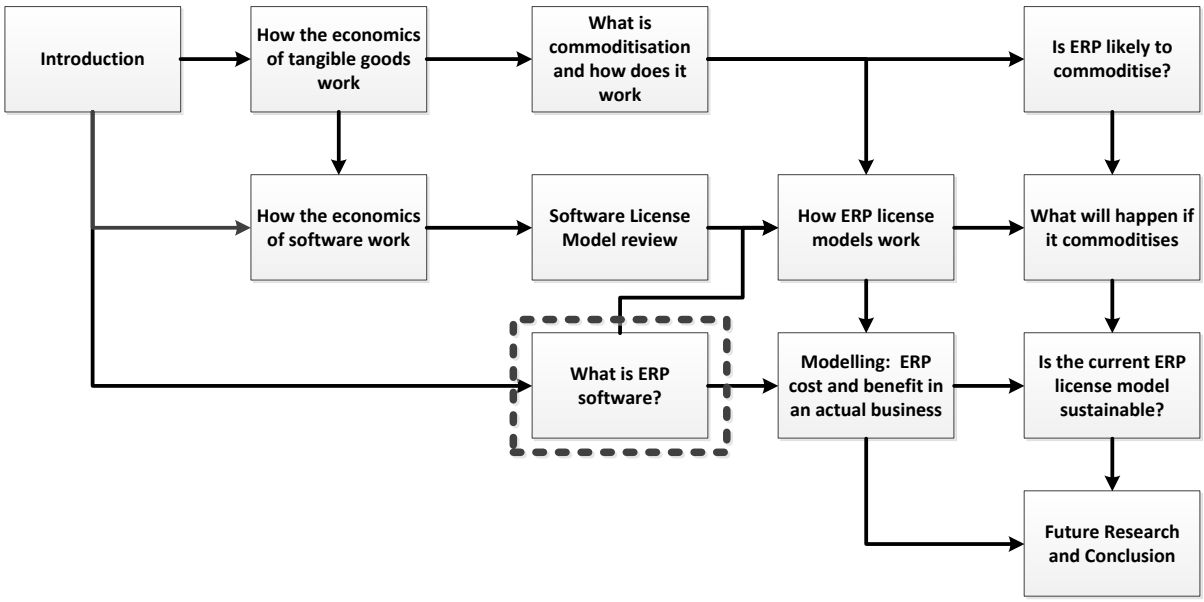

Figure 7: Document Map

Enterprise Resource Planning (ERP) is the term that was coined by Gartner (Herald, 2001) in the nineteen nineties to describe the breed of business software that uses a centralised data store to facilitate all key functions of an enterprise (Johansson & Sudzina, 2008) such as

- Accounting
- Human Resources
- Production Planning
- Sales and Distribution
- Etc.

The concept has expanded in recent years to include non-core business functions such as Plant Maintenance, Customer Relationship Management and Business Intelligence.

The key advantage of using a single ERP system over best-of-breed business applications (such as a specialised payroll or accounting system) is that everything is interconnected and all the business functions use the same "master data" (O'Leary 2011).

Most scholars agree that regardless of whether ERP delivers a competitive advantage or not, investors will not pay much attention to publicly listed enterprises that have not yet entrusted their Accounting, Human Resources and Manufacturing functions to a centralised ERP. So much so, that by 1999 70% of the Forbes 1000 firms has installed ERP (Poston & Grabski 2001).

2.4 Commoditisation

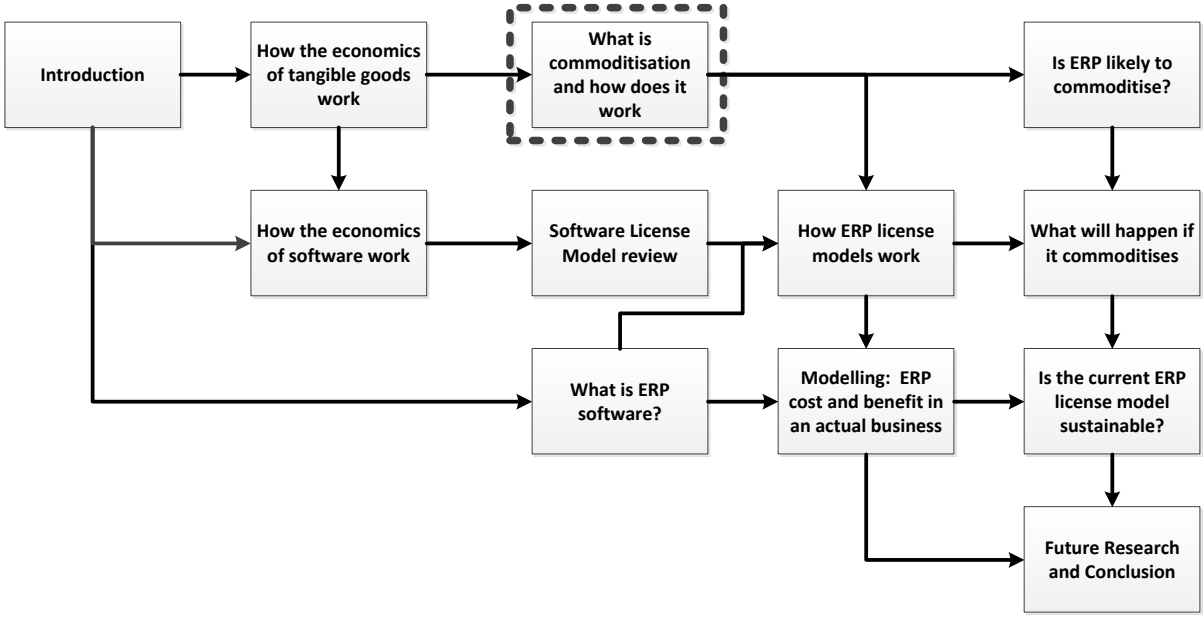

Figure 8: Document Map

"In order to escape the curse of commoditisation, a company has to be a game changer…"-Gary Hamel.

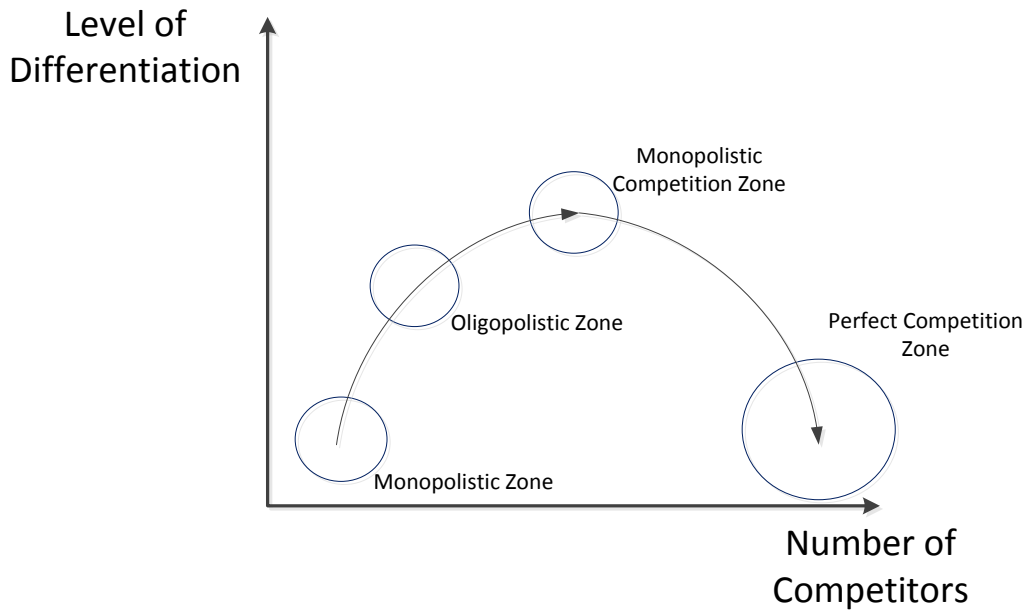

Figure 9: Journey from Monopoly to Perfect Competition

Commoditisation is not to be confused with the Marxist concept Commodification which refers to the process of assigning an economic value to goods that they did not previously possess. In this sense, Commoditisation refers to the process of a differentiated product, becoming an undifferentiated, perfectly substitutable good (Weil, 1996).

Another way to view commoditisation of goods is to identify it as the journey that a specific market segment takes from a monopolistic market to a purely competitive market.

In "Figure 9: Journey from Monopoly to Perfect Competition", the x-axis represents the number of competitors in the market whereas the y-axis represents the level of differentiation between the competitor products.

All markets start out as Monopolistic markets. Depending on a range of factors, the monopolies may sooner or later be challenged by a second, third and so on competitor to enter the market.

The factors that determine the likelihood of this include (Reimann et al., 2010):

- Porter's five forces
- Scarcity of skills, raw material or manufacturing capability
- Industry stability
- Trade secret, patent protection or other regulatory/compliance advantages
- Complimentary assets and vertical integration
- Any other supply chain related advantages

Whatever the reason may be, very few markets remain monopolies for long periods of time. Even if a market has high barriers to entry, it would often at least become duopolistic or oligopolistic at least (consider the big-four banks in South Africa).

Some other markets settle at the stage of Monopolistic Competition (consider breakfast cereals in South Africa).

And other markets become perfectly competitive (consider Portland cement).

Examples of the different markets:

Monopoly: Microsoft

Whilst Apple Inc. have made strides in the upmarket personal computer, Microsoft still operates a monopoly in the low to mid-end personal computer software.

Oligopoly: Banking in South Africa

Whilst there are more banks (banking licenses) in South Africa than the layman would realise, the market is effectively shared by the "big four" retail banks.

Monopolistic Competition: Breakfast Cereal

These days there are countless breakfast cereals on the shelf. Although all of them originate from two or three grain staples, this is arguably one of the most differentiated markets.

Each brand uses a strong brand message and often cartoon characters to differentiate itself in the eyes of the buying centre (4-10 year old children).

Pure Competition: Portland Cement

Whilst there are only a handful of cement producers in South Africa, globally this is a purely competitive market.

2.4.1.1 ERPs and Commoditisation

As far as commoditisation is concerned, the ERP market also started as a monopoly in the 1970's with SAP being the sole incumbent for many years (Rashid et al., 2002). When Oracle secured their position as competitor in the 1980's, the market remained a duopoly for the next two decades. It was only in the 2000's that the market turned full oligopoly with the SAP and Oracle duo losing their more than 80% combined market share. In a recent Panorama report (Panorama, 2012), SAP and Oracle together only have roughly 35% of the overall market share.

Is the ERP Market at Monopolistic Competition?

SAP would likely say that it is a monopoly. Oracle corp. would likely state that it is a duopoly and Microsoft that it is an oligopoly.

Smaller firms such as Infor may even say that it is purely competitive.

The matter of the fact is (Panorama, 2012; Columbus, 2013):

1. There are more than 100 commercial ERP systems available today
2. The top two firms control about a third of the market
3. However, the top five firms do not control at least 50% of the market

Thus, the reasonable conclusion is that the ERP market is currently in a state of "Monopolistic Competition".

With over a 100 proprietary ERP packages on the market and the top five commanding less than 50% of the market share, the ERP market has also arrived at destination: "Monopolistic Competition".

2.4.1.2 Are modern ERP systems differentiated?

An interesting observation from the "Level of Differentiation" diagram is that the diagram suggests the level of differentiation to be higher in a monopolistic competitive market than in an Oligopolistic market. Intuitively this makes sense: there is far more differentiation between the brands of breakfast cereal than there is between the cheque-accounts offered by the big four banks in South Africa.

This begs the question of where the great differentiation lies for the ERP market? The author postulates that this too (perhaps a bit prematurely) has come and gone.

There was an era in the early 2000's where every small ERP company (that survived the ".com" bubble) decided to specialise their ERP or focus on a specific niche market (Ljungqvist & Wilhelm, 2003). Whether it was line of business (retail vs. manufacturing) or size (Small Enterprise vs. Medium Enterprise) oriented.

As time went on, the customers of these niche ERP systems either grew or diversified. This meant that the ERP systems had to adapt to their customers' requirements or their customers would inevitably move on (Rashid et al., 2002).

The result is that we have a quickly commoditising ERP market with all the ERP systems converging on the same set of features and functions.

2.5 Research Issues

The previous sections provided an introduction to the economics of manufactured goods as wells as how software departs from this economic model. It was also illustrated how the ERP market has changed from a monopolistic market in the 1980's, through oligopoly in the 1990's to become the monopolistic competitive market that it is today. This progression follows the pattern that was proposed in the diagram "Figure 9: Journey from Monopoly to Perfect Competition".

This section will explore the research issues that this poses, based on the research question:

"Is the current Tier-1 ERP License model sustainable in a perfectly competitive market?"

It is crucial to remember that the aim of this research is **not** to test whether the ERP Saving actually exceeds the cost of ERP. Should the ERP market commoditise, the price equilibrium converging on the value will be a natural effect of commoditisation.

One of the aims are however to test whether there is a link (correlation) between the cost of ERP and the saving that it yields.

2.5.1 Research Problem

The author postulates that the ERP market is moving towards a purely competitive market. Unfortunately, whether this postulation is an inevitability is impossible to measure and prove/disprove. However, considering the available knowledge; this is definitely a potential future and is therefore worth exploring.

In a purely competitive market, goods are usually sold at their intrinsic value, or at their marginal cost (Stahl, 1989).

This poses a challenge for software, since it was shown previous sections that:

1. Software has no intrinsic value
2. Software has no marginal cost, only a high fixed cost (Church and Gandal, 1992)

Although software may not have any intrinsic value, it does possess considerable instrumental (utility) value if it is applied in the proper context.

According to the literature (Dedrick et al., 2003; Gattiker & Goodhue, 2005; Hunton et al., 2003; Nicolaou, 2004; O'Leary, 2004), this instrumental value of ERP systems translate into:

- Tangible (monetary) benefits
- Intangible benefits

The tangible benefits are for example the saving on labour cost as a result of reducing headcount realised through the efficiencies that ERP enables in operations.

Intangible benefits refer to indirect monetary benefits such as reducing operational cost based on the information and decision making ability that ERP provides to the management staff of a firm.

In the postulated (purely competitive) future market, ERP license cost will not be able to exceed the sum of these tangible and intangible benefits.

Table 1: Research Problem

Research Problem	
Problem:	To establish whether the total license cost linked to the value that customers are getting from ERP.
Hypothesis:	The total cost of Tier-1 ERP licenses is not linked to the total saving (direct and indirect) that ERP yields.
Purpose:	The reason that it is important to understand whether the license fees (under the current ERP license models) are linked to the value is that: This will prove whether ERP vendors have been successful to align the cost and benefit of ERP's.

It is thus assumed that if there is no link (or a very weak link) between the cost and saving of Tier-1 ERP systems, then the license model cannot be sustainable in a purely competitive market.

2.6 Conclusion

The reality about the ERP market is that: enterprise software is becoming increasingly homogenous. With more and more entrants entering the "large enterprise" ERP space, all the symptoms for commoditisation (Hofmann, 2008) are starting to surface. This could eventually leave behind a highly competitive ERP market that will share a common license model.

Research indicates that they buyers of Enterprise Software (CIO's and IT Directors) would be willing to pay slightly more for software, provided that the firm's IT spend remains predictable (Konary et al., 2004)

The reverse of this argument is that ERP systems are so complex and expensive that simply charging for the installation or for the amount of users using the system would not be fair. "Company A" may

achieve much more from an ERP system with 3 users than “company B” using 50 users; in this regard then “Company A” should pay more since they are gaining more value from the use of the software.

The results from testing the two hypotheses stated in this chapter will provide reliable information on which to build a framework for a sustainable ERP license model.

In the following chapter, the methodology of addressing the research question will be explored in depth as well as further exploring definitions and concepts required in testing the hypothesis.

3 METHODOLOGY

3.1 Introductions

In the previous chapter, the key research issues were identified along with the concepts and themes from the literature that contextualise these specific research issues.

This chapter will detail the methodology that is proposed to unpack and test the proposed hypothesis. Along with the methodology, definitions of some key concepts such as software licensing metrics will be provided.

3.2 Definitions Considered in this Research Report

The level of complexity of the competing license models are a key theme in the research problem under investigation. It is therefore imperative to perform a software license review in order to unpack the inner mechanics of different license models before the research methodology can be successfully proposed.

The following section will start by reviewing the basic makeup (mortality and licensing metrics) of all software licenses. This is followed by a literature review of general software licenses juxtaposed with a review of specifically ERP license models in order to show how the ERP market still exists greatly isolated from other proprietary software.

3.2.1 Software License Model Review

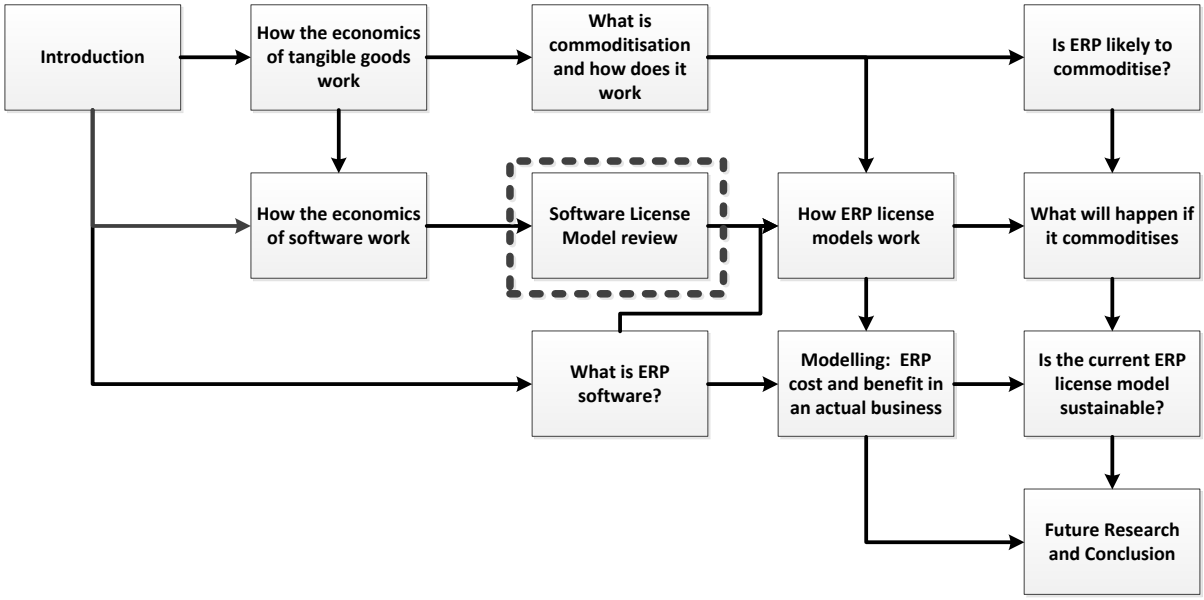

Figure 10: Document Map

3.2.1.1 Introduction

An End-User License Agreement (or EULA) serves two very important functions:

1. It serves as the legal contract between the software vendor and customer on how the software will be used and how the vendor will support the end-user when using the software in a compliant fashion
2. It is the primary mechanism that determines how a software vendor's income is generated

Whilst the first function of a EULA is well understood and accepted by the customer and vendor alike; the latter function is often only understood by a select few deep within the strategy and accounting departments of software companies.

The cash-flow of a software vendor that only sells once-off licenses would look very different to that of a software vendor that sells subscription software (Lehmann & Buxmann, 2009). This is a key perspective that one has to be mindful of when exploring the evolution of software license models.

For an end-customer, the key perspective is to get "value for money" (Harmon et al., 2005). Therefore, if a customer is paying for software on a subscription basis, they are likely to stop paying if they feel that they are not getting value from using the software.

3.2.1.2 License Model Review

The author conducted a review of the available literature in compiling the results for this section (Bakos & Brynjolfsson, 2001; Bontis & Chung, 2000; Cusumano, 2007; Fishburn & Odlyzko, 1999; Konary et al., 2004; Lehmann & Buxmann, 2009).

Software license models can be categorised by two major dimensions:

- License Mortality
- License Definition Metric

3.2.1.2.1 License Mortality

The first category refers to the lifetime and determinant of the license lifetime. There are three members to this dimension:

- Perpetual License
- Subscription License
- Usage Based

In order to explain the three types of licenses consider the following analogy of "paying for accommodation". The perpetual license can be likened to buying (and paying in full) for a house. Apart from running costs and property taxes the owner can choose to use the house at any time without paying any additional fees.

The subscription based license can be likened to a rented apartment. There is usually a contract in place that stipulates the payment of a monthly fee to the owner/lesser. For as long as the lessee pays the monthly fee, under the contract they have exclusive, unlimited use of the accommodation.

The usage based license can be likened to hotel accommodation. The customer may use the hotel accommodation at any given time and will only be charged for the times that he/she actually occupied the accommodation.

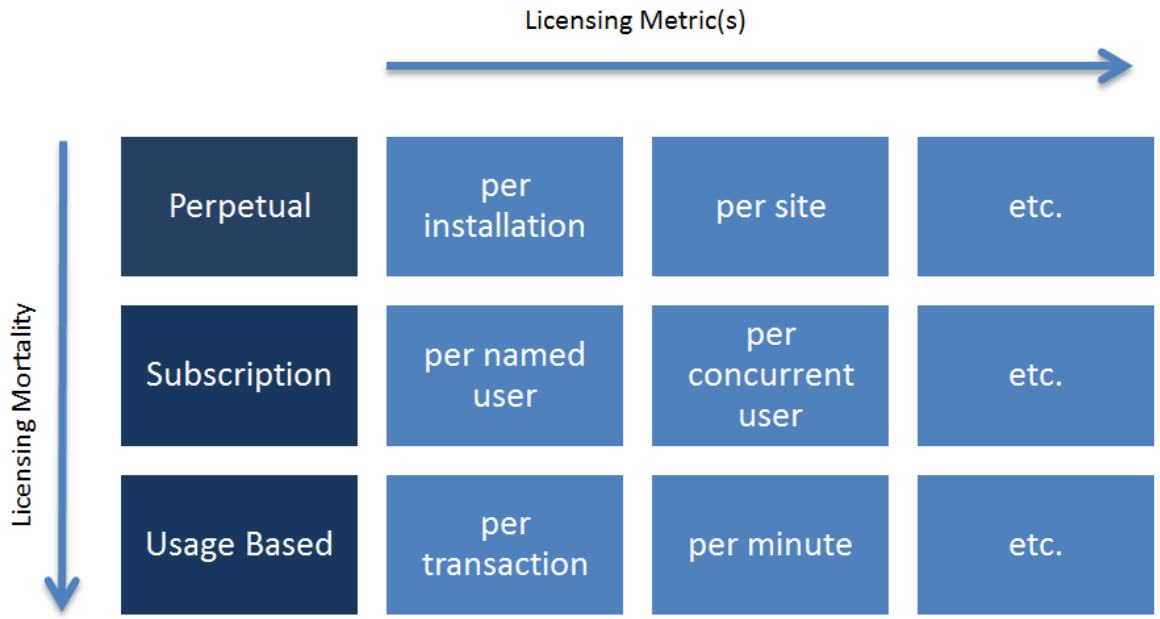

Figure 11: Dimensions of Software Licensing

3.2.1.2.2 License Metric (Definition)

The licensing dimension deals with the metric or definition of what type of usage the license allows for. Examples of these are: per-user, per-installation or per server.

For consumer software such as anti-virus or basic word-processors, the EULA is typically a perpetual, single-metric license where the metric is usually based on the number of active installations of the software. This means that 99% of consumer software specifies that the user may use the software forever and that the user may have (typically) 1 or 2 installations of the software running at home.

Enterprise software packages on the other hand typically have much more complicated license models, containing many different metrics and sometimes even different mortalities.

3.2.1.3 Software License Summary

In the following summary of the literature review results, the author has constructed a cross-functional matrix between the various types of license models at the types of software that they are most often associated with.

In Table 2: one, two or three tick-marks indicate the strength of the correlation between the license model and its use in the specific category of software.

The column headings in Table 2 represent the functional category of software.

The first column in Table 2 represents the main license model types identified in the literature survey. In some cases such as “Usage Based Pricing” there are applicable license metrics that are indicated in the second column.

Table 2: Typical application of different software license models

License type	License Metric	Legacy Business Software	OEM Software	Middleware (DB, Integration etc.)	Business Intelligence Software	Enterprise Software	Expert Software (e.g. CAD)	SaaS (web based, on demand)
Flat Perpetual Pricing			✓✓✓	✓✓	✓			
Functionality Tiered-Pricing			✓				✓✓	✓✓✓
User Based Pricing	Concurrent User			✓✓✓	✓✓	✓		
	Named Used		✓			✓✓✓		✓✓
	Highwater	✓✓					✓✓✓	✓
Usage Based Pricing	Cost Plus Pricing				✓✓	✓✓✓	✓	
	Per Master Data Item			✓✓		✓✓✓		✓
	Complementary Pricing		✓✓✓		✓		✓✓	
	Remix	✓✓✓			✓		✓✓	
	MIPS	✓✓✓		✓			✓✓	
Beta			✓✓✓	✓			✓✓	
Capacity	Per CPU	✓		✓✓✓	✓✓			
	Per server	✓✓		✓✓✓	✓			
Cross License			✓✓✓				✓✓	✓
Demo or eval.			✓✓✓		✓			✓✓
Development				✓✓✓	✓	✓✓		
Freemium			✓✓				✓	✓✓✓
Overdraft		✓✓			✓		✓✓✓	
Bundling			✓✓✓		✓	✓✓		
Site		✓✓		✓✓✓		✓		
Time Limited		✓✓					✓✓✓	✓
Upgrade Dates and Version			✓		✓✓		✓✓✓	

To review a detailed explanation of how the different software categories are distinguished from one another, as well as how the different license models operate, please see: **APPENDIX A - SOFTWARE LICENSE MODEL REVIEW**

3.2.2 ERP License Model Review

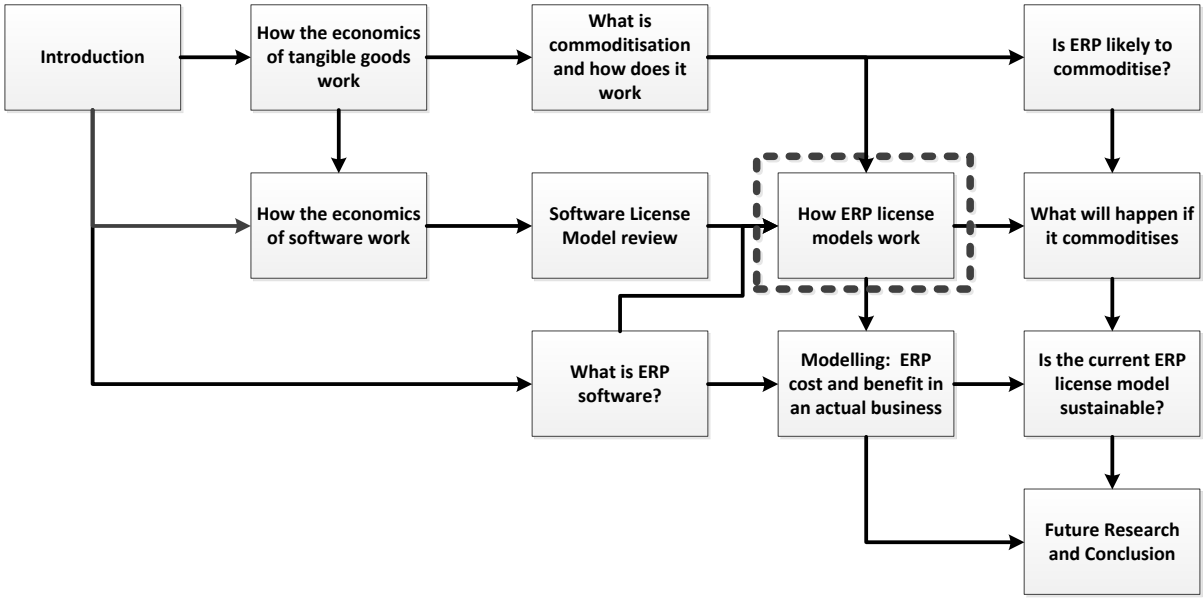

Figure 12: Document Map

Tier-1 enterprise software packages typically have more complex license models than consumer software (SAP 2012, Oracle 2013). These license models include:

- Various types of user licenses (named user vs. concurrent user, full user vs. limited user)
- Server or Installation Licenses (number of servers used in the landscape)
- Interface licenses (number of external systems connected to software)
- Physical Usage licenses (number of data objects or sales orders processed)
- Disk Usage licenses (number of Gb that the data grew by in the last year)

This creates a very complicated licensing landscape with some researchers for and others against the complicated nature of ERP licenses.

An industry-wide survey (Konary et al., 2004) gave clear evidence that both software vendors as well as software customers feel that typical enterprise license models are too complicated and would prefer simpler license models.

Software vendors indicated that they would prefer simpler license models to be able to simplify the license audit process that they have to complete every year at each customer.

Software customers indicated that the reason they would prefer simpler license models is to be able to predict their annual IT-spend more accurately (Konary et al., 2004). The obvious flaw in this second observation is the fact that CIO's and IT directors are measured on the accuracy of their budgetary process rather than the return on investment they were able to realise from their IT-spend.

Despite these very clear indications from surveys, a decade on, the software license models for the Tier-1 ERP systems have become more complicated if anything.

The main argument for the complicated nature is that it allows the vendor to charge the customer based on the amount of value that they are gaining from using the software. As an example, let's assume that an ERP is licensed on user-licenses alone. If customer A's three users are able to process the same amount of sales orders through its ERP as customer B's six users, customer A is realising the same benefit than customer B, yet paying half of what customer B is paying.

By licensing the ERP on both user-licenses as well as amount of sales orders, the vendor curbs this effect. In this case, the value adding activity is identified as the amount of "sales orders processed" and by adding this metric to the licensing, the vendor normalises the potential disparity mentioned in this example.

As noble as this complicated way of licensing software may seem, the net effect behind their license model is a secret that Tier-1 ERP vendors keep very close to their chests. The more licensing metrics are added to the overall license model, the more difficult it becomes for customers to see the alignment between value and cost of licenses.

The interesting trend that is emerging is that new (Tier-2) entrants into the ERP market typically have very simple, transparent licensing models (Microsoft, 2013). These ERP vendors often even publish their license models and price lists online for everyone to see.

3.3 Research Methodology

The research design should achieve the following objective:

- Determine whether ERP License Cost is linked to ERP Value (Savings)

The research design will use a software (model) simulation to achieve this objective. The software simulation should be entirely capable of determining the existence and strength of the "cost/saving linkage".

3.4 Research Design

The following research design was devised in achieving the abovementioned goal:

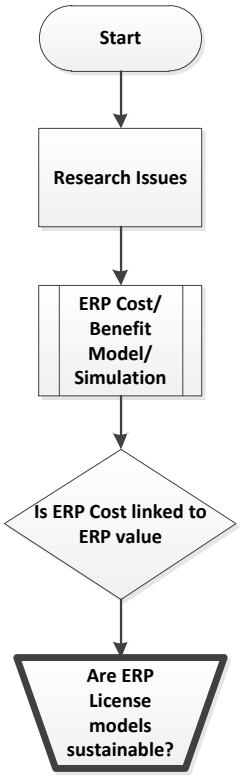

Figure 13: Research Design

Once the data has been collected and analysed from the computer simulation, the uncertainties in the research issues should be satisfactorily answered in order to make a conclusion about the likely outcome of the research question.

3.5 Computer Simulation

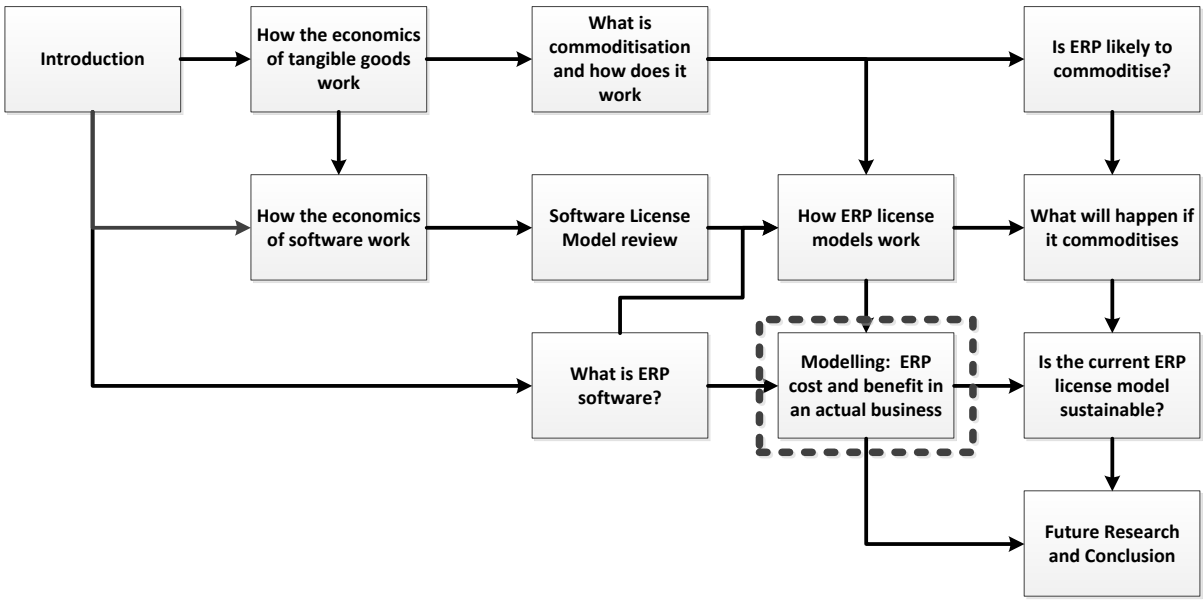

Figure 14: Document Map

The following section will delve into the architecture of the software model that was employed in conducting this research.

3.5.1 Computer Simulation

The purpose of the computer simulation is to investigate whether there is strong link between the license fees that customers pay and the benefit that is realised from using the ERP.

Whilst not all the benefits of using an ERP can be expressed in exact monetary terms, the aim of the simulation is not to financially balance the cost and benefit but rather try to measure if there is a statistical correlation between the license fee increase/decrease and the benefit increase/decrease.

In addition to this, the robustness of this correlation (if any) should be tested. This means that the strength of this correlation should also be tested under different market (and other) conditions. Whilst an "ideal" business scenario may exhibit a strong correlation between ERP cost and ERP saving, runaway inflation or stressed profit margins may indicate a serious deterioration in this illustrated correlation.

This type of simulation relates to the "black-box" approach used in software and system testing. In this mode, the tester chooses to apply actual inputs and monitor the outputs without trying to develop a mathematical model of how the system will behave (based on deeper investigation of its internal workings).

3.5.1.1 Background to the software model

Trying to find an "umbrella" use-case for the use of ERP software will be near impossible; however the origins of ERP provide a good starting block to work from.

Since ERP systems were born in manufacturing sector (Rashid et al., 2002), this is a good Line of Business (LoB) to use in the simulation. Even just within the manufacturing sector there exist many different use cases for ERP however.

The business that was modelled was also selected based on simplicity of its manufacturing process, thereby favouring the common (undifferentiated) functions across ERP systems and excluding specialised (niche) manufacturing ERP systems.

3.5.1.2 Business to be modelled

As a result of the criteria discussed, a modern day bread bakery was selected as the business that would be modelled. The bread-baking process is a very simple manufacturing process that is identical across almost all geographies globally.

In addition to this, bakeries (especially medium sized, independent bakeries) can exist with or without an ERP. Contract bakeries (such as the one that was modelled here) have extremely simple supply chains that typically only have one supplier and one customer and no logistics.

3.5.1.3 Type of simulation/modelling

The other key decision in the setup of the simulation deals with deciding what type of analysis to conduct.

The primary aim of the simulation is to test the correlation between "ERP Cost" and "ERP Saving"; as well as testing the robustness of this correlation under varying market conditions. The "One

variable At a Time" (OAT) sensitivity analysis was selected as the appropriate analysis method for achieving the objective.

The OAT sensitivity analysis relies on different (black-box) test cases or scenarios where each scenario would allow for a different input variable to be swept across a range of values, whilst a set of output variables are monitored (Homma & Saltelli, 1996). Regression (Linear or higher order) is then used to determine the robustness of the system's response to the varying inputs.

3.5.1.4 Modelling Software

The decision of which modelling software to use is greatly influenced by the type of analysis that will be conducted.

Since the chosen simulation/analysis will be conducted by means of sensitivity analysis, the most optimal software packages are:

- Mathworks Matlab
- SAS Statistical Software
- Visual Basic (using Microsoft Excel VBA scripting)

Whilst Matlab is a very powerful package with the ability to execute on clustered supercomputers, it is not an ideal fit for this specific application. During the build phase of this model, many adjustments and tweaks will be required. With Matlab, making simple adjustments to any model requires extensive additional scripting and re-programming.

SAS Software, although less complicated than Matlab to set up and reconfigure still falls within the category of "heavyweight" statistical processing, whereas the requirement would only need a simple linear regression algorithm to be conducted.

Microsoft Excel VBA is a powerful, versatile use of the Visual Basic language to build simple to intermediate models on a very intuitive (spreadsheet based) front-end (Microsoft Excel). Whilst Microsoft Excel has a limitation in terms of the volume of data that it can handle (the other software

packages do not), the simulation in question will unlikely come within a 1000^{th} of Excel's data limitations.

Microsoft Excel (as front end to the simulation) also has far superior graphing and display capability compared to the other two packages.

3.5.1.5 Model Architecture

The model was based on a medium sized bread bakery that performs contract baking services to a larger food-conglomerate.

In this type of arrangement a bakery usually sources its raw material from the same supplier that supplies (or is owned by) the food-conglomerate as to ensure the same product quality (compared to other bakeries used by the food-conglomerate).

This type of bakery usually also has the same food-conglomerate as its only customer. The food-conglomerate would then provide the contract bakery with daily orders based on the demand detected in the area that the specific bakery serves. If the order is less than the installed capacity (daily amount of bread the bakery can bake), the bakery is free to do with its additional capacity whatever it chooses to do (bake bread for local convenience stores etc.). However, if the daily order is more than what the bakery can handle, the bakery is responsible for finding other contract bakeries that it can outsource the additional work to.

In other words, the contract bakery is obliged to deliver the daily order to the food-conglomerate, whether this is more or less than its installed capacity. At the end of the day, the conglomerate is only concerned with taking delivery of the exact order size at the agreed price.

Although this may seem strange from the food-conglomerate's perspective, this outsourcing arrangement is quite common across many lines of business. It allows the larger conglomerate to focus on its core competency (which is usually supply chain and logistics) whilst the smaller bakery can focus on its core strength (baking) without having to manage many suppliers or customers.

In this simplified model, the bakery can be best illustrated by the diagram below:

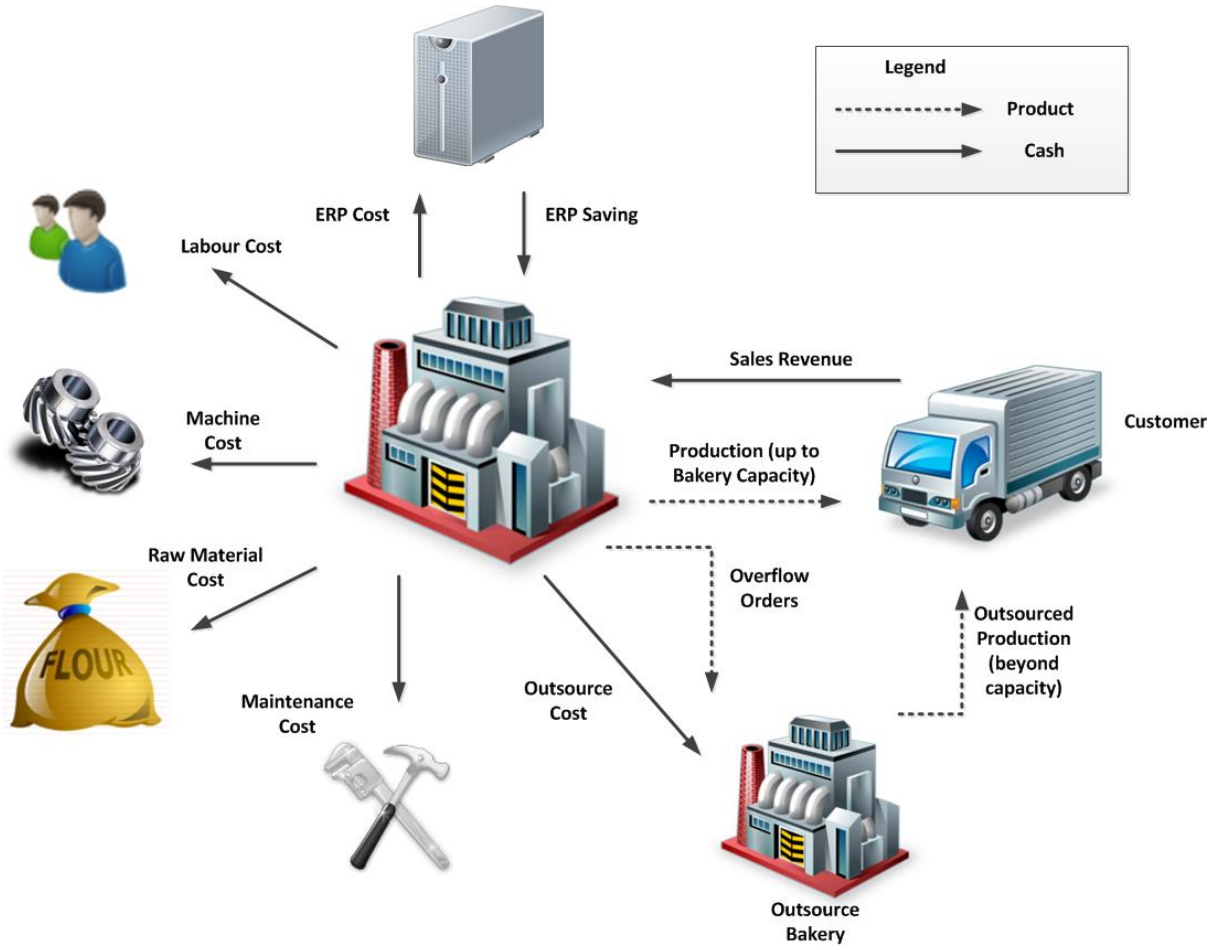

Figure 15: Bakery (Software) Model

The bakery has the following costs:

1. Raw material cost e.g. flour, water, yeast
2. Machine Cost e.g. gas, electricity
3. Maintenance Cost e.g. Rotables, Consumables, Cost of Downtime
4. Labour Cost: Salaries
5. Outsource Cost: Cost of outsourced (overflow) production
6. ERP Cost e.g. License fees, implementation cost and hardware cost

The only source of income for the bakery is the revenue from selling the produced bread to the only customer.

Although this (sale of bread) is technically the only source of income, the ERP system is also modelled to provide certain "savings" depending on some other variables in the model. This was done as to be able to measure both the cost as well as the saving of the ERP separately.

An example of such a saving is modelled through the labour-cost reduction (based on reduced headcount). Many studies have shown that ERP's allow the company to achieve the same output from a smaller workforce through efficiencies realised in the back office operations.

The list of benefits (savings) were derived from many pieces of literature (Gattiker & Goodhue, 2005; O'Leary, 2004; Hunton et al., 2003) that investigate and explain the potential savings that ERP bring about.

It was assumed that the modelled benefits (savings) will not take full effect on the first day after the ERP "go-live". The intensity (effect) of these benefits (as a function of time) were modelled on the seminal work by Gattiker (Gattiker & Goodhue, 2005) showing the relative level of benefit realised from an ERP over the first 48 months post "go-live".

Since this is primarily a relative measure of correlation between the ERP Cost (License Fees etc.) and Saving (Maintenance Cost Saving etc.), there is no need to be accurate in terms of the magnitude of each saving (since one is only testing for linearity of response). It was observed however that the baseline values were modelled quite accurately, having compared the model with real-life business scenarios comparable to this.

3.5.1.6 Autonomous Model Intelligence

In addition to automatically calculating the daily business and ERP transactions, the model has a higher level of decision-making autonomy built-in.

This decision making capability called the “annual review” process runs once per annum (in simulation-time not actual-time) and makes key decisions about the makeup of the business, as an annual review board typically would.

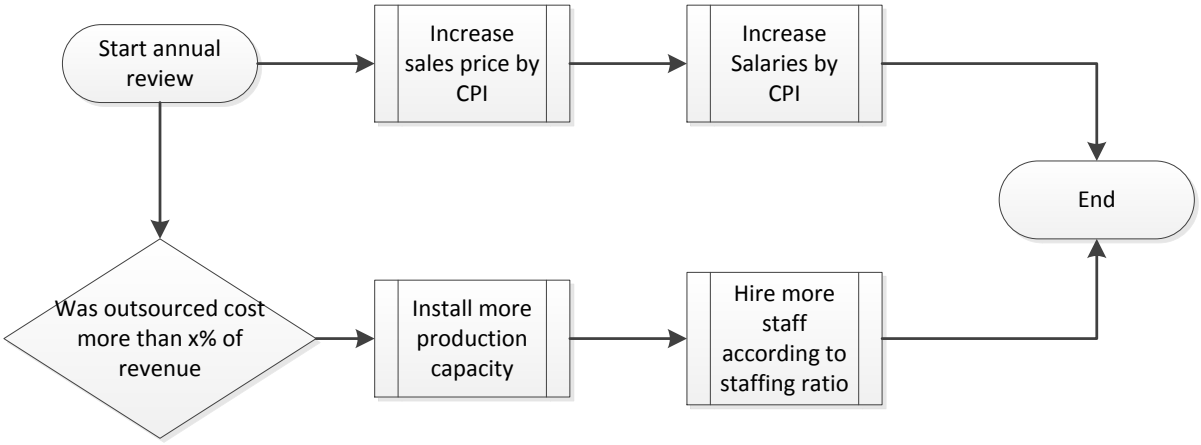

Figure 16: Autonomous Intelligence in Software Model (Annual Review Process)

Each time the annual review runs, it calculates whether the cost of the outsourced baking (that the bakery did not have capacity for) during the last year. If this cost is found to be above a certain threshold parameter (12%, but may be adjusted), it will trigger a process to expand the bakery capacity.

This process is similar to capacity expansion in an actual bakery and includes hiring additional staff, buying additional ERP Licenses etc.

3.5.1.7 Baseline Parameters

Each of the baseline parameters (salaries, cost of bread etc.) were set up using some industry accepted norm or scientific approach.

The baseline salaries and salary spread for example was determined by using values from a whitepaper released by the South African Government Statistics department on surveyed salary spreads and distributions in the South African manufacturing industry (Statssa, 2010).

The Consumer Price Index (CPI) percentages were extracted from historical records on the South African Reserve Bank website (SARB, 2013).

The baseline cost of bread was back-calculated from the current price using the historical CPI values and cross-check for some years against historical publications of the bread price.

3.5.1.8 Software License Cost

The software license cost that was modelled into the computer simulation was based on the average license cost from the Tier-1 ERP vendors. Although each vendor has their own specific naming conventions and license metrics, there is enough similarity between the licensing of the Tier-1 vendors to create generic license types that represent the Tier-1 ERP market sufficiently.

Each of these identified license types were coded into the transactional processing of the computer simulation. An example of this is the sales orders that are processed in the computer simulation. Each Sales Order processed automatically attracts the cost associated with the "Sales Order Processing" license metric. Similarly, any new employees that the computer simulation decides to employ would attract the cost associated with providing these new employees with an appropriate user license for the ERP.

Table 3 is an excerpt from the computer simulation that contains the lookup table for the various license types, metrics and their associated costs.

Table 3: ERP License Cost Lookup Table for Computer Simulation

Application Area/ License Type	Block Size	UOM	Metric to be measured	Block Price
ERP User Licenses				
Office User	1	User	Office Users	R 40 000
Shop Floor User	1	User	Shop Floor Users	R 7 000
Business Intelligence	25	Sessions	Per Concurrent User Session	R 900 000
ERP Base Installation License				
ERP Package	1	Installation	ERP Installations	R 200 000
Transactional Licenses				
Sales and Service Orders Processed	1 000	Orders	Orders per Year	R 1 200
Purchase Orders Processed	1 000	Orders	Orders per Year	R 2 300
Payroll Processing	500	People	Master Records	R 90 000
Credit Management	1 000	Cust./Vend.	Active Customers / Vendors	R 40 000
Direct Biller	1 000	Cust./Vend.	Active Customers / Vendors	R 40 000
Revenue Collections	1 000	Cust./Vend.	Active Customers / Vendors	R 90 000
Raw Material Sourcing	10 000 000	R	Spend Volume	R 12 000
Invoice Management	1 000	Invoices	Number of Invoices	R 9 000
System Diagnostics	1	Cores	CPU	R 100 000
Business Process Management	1	Cores	CPU	R 500 000
Master Data Management	5 000	DB Rows	Master Data Objects	R 1 200 000
Database License	10	%	Percentage of total spend on other licenses	

3.5.1.9 Simulation

The different scenarios or test-cases each require a full run of the model, known as a "simulation run".

Each simulation runs on a daily level (daily production order level) for more than 12 years from January 2001 to October 2013, causing 3196 sets of transactions for each iteration of the model.

The model has been designed to allow the simulation user to set up a scenario-run by clicking through a wizard that prompts the user to select all the required parameters for a scenario-run.

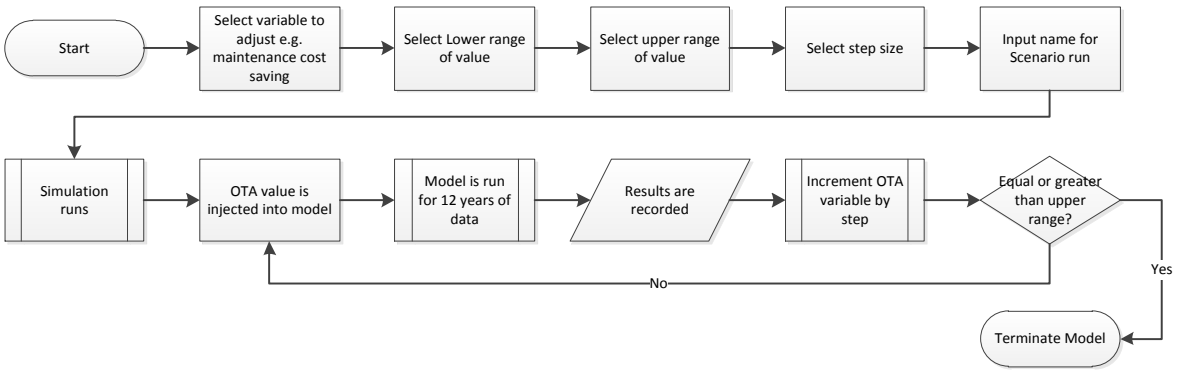

Figure 17: Process Flow Diagram of a scenario-run

During the scenario run, the model increments the OAT value by the indicated step size before running the full 12 years' worth of input data against the model, after which the output data is captured.

This process repeats until the model has reached the upper range for the OAT variable, after which the simulation run terminates.

3.5.1.10 Visual and Statistical Analysis

The VBA code uses sub-routines to calculate key analytical metrics such as Internal Rate of Return, Compound Annual Growth Rate (CAGR) and Return on Investment (ROI) period.

There are additional sub-routines built into the overall VBA Code that allow for the instantaneous charting (x-y scatter) and linear regression testing on all of the key metrics in the analysis.

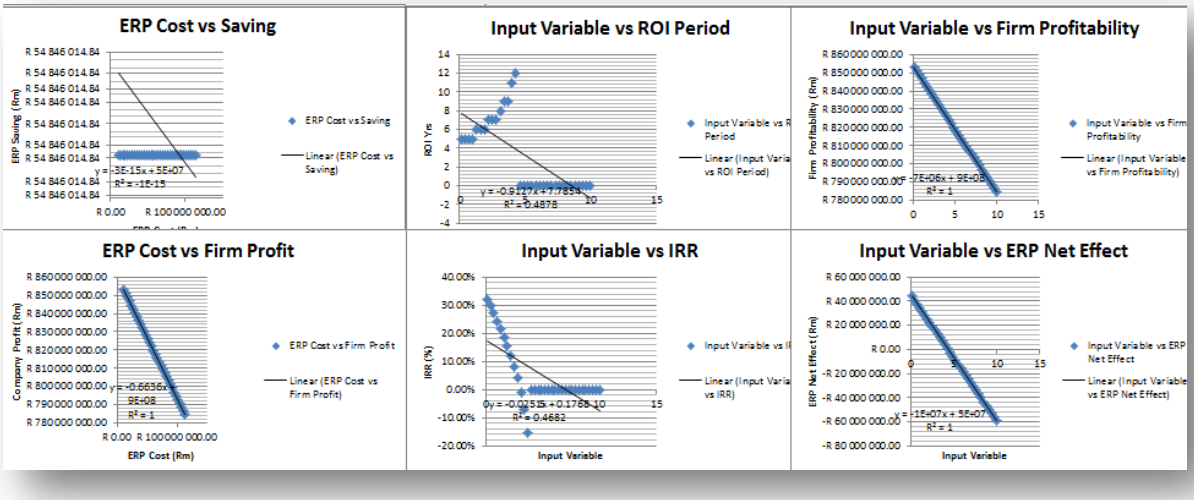

Figure 18: Visual Output from Scenario runs

3.6 Conclusions

This chapter started by defining the basic mechanics of any software license namely its mortality and the concept of licensing metrics. Following this, the author presented a literature review concerning general software licenses as well as specifically ERP software licenses. This illustrated how ERP licenses (at present) seem to favour certain licensing metrics and are overall more complex than other consumer software.

Finally the researcher presented the research methodology that is proposed to test the hypothesis proposed in the previous chapter by means of a computer simulation model.

The next chapter will examine the data that was produced as a result of executing the proposed research design.

4 ANALYSIS OF DATA

The previous chapter explored the design of the computer model/simulation.

In this chapter, each scenario (test-case) used in the computer simulation will be introduced and explored. This is followed by the (high-level) results and discussion of each scenario.

For a detailed account of all results from the computer simulation, please see: **APPENDIX B – SIMULATION RESULT DISCUSSION** or **APPENDIX C – SIMULATION RESULT CHARTS**

This chapter's main objective remains to present and explain the results of the research; the interpretation and conclusions will be drawn in the next chapter.

4.1 Simulation

4.1.1 Introduction

The software simulation was primarily intended to test whether the ERP value (saving) that customers experience is linked to the license cost paid for the ERP system.

It is important to stress that it was not the primary intention to see whether ERP customers can save more money than they spend on the ERP, however this is the parameter that was used to determine the level of correlation.

This section will start by giving a brief review of the simulation model and the simulation runs. After that, the different variables that were selected for OAT simulation runs will be mentioned, explained and justified.

Finally the simulation results will be presented.

4.1.2 Simulation Runs

Historical data is used to simulate daily production orders and the model calculates and processes all the typical transactions that would take place in a bakery from day to day.

Various monitoring points were recorded throughout the simulation run. These data are then used after each simulation to calculate various statistical measures such as linear regression correlation coefficients, Internal Rate of Return (IRR) and so on.

These statistical results were then plotted on x-y scatter plots in order to understand the input/output relationship as per the "black box" approach.

4.1.3 Scenario overview

The following scenarios were executed against the computer model:

Table 4: Scenario Summary

Nr	Scenario Name	Type	UOM	Range	Step
1	Raw Material Cost below Sales Price	Market/ Economic	Fraction (%) below sales price	0.05 to 0.9	0.03
2	Order Size	Market/ Economic	Multiplier (baseline = 100)	10 to 400	20
3	Base Price of Bread	Market/ Economic	Rand (2001 sales price of bread)	0.1 to 10	0.3
4	Outsource Baking Cost	Market/ Economic	Rand per loaf (in 2001, CPI adjusted)	1 to 20	1
5	Base License Cost of ERP	ERP Pricing	Multiplier (baseline=1)	0.1 to 10	0.3
6	ERP Volume Spend License Fee	ERP Pricing	Multiplier (baseline=1)	0.1 to 10	0.3
7	Maintenance Cost	Market/ Economic	Fraction (% of machine cost)	0.001 to 0.1	0.002
8	User License Cost	ERP Pricing	Multiplier (baseline=1)	0.1 to 10	0.3
9	ERP Order Volume License Fee	ERP Pricing	Multiplier (baseline=1)	0.1 to 10	0.3
10	Competitiveness Bonus	Implementation/ERP	Multiplier (baseline=1)	0.1 to 10	0.3
11	Inflation	Market/Economic	Multiplier (baseline=1)	0.1 to 10	0.3
12	Only user license (Order Size var.)	Experimental	Multiplier (baseline = 100)	10 to 400	10

The scenarios represent a mix of Market (Economic), ERP Pricing, ERP/Implementation Quality and even experimental conditions.

Each scenario was chosen for a specific purpose (which will be justified in the sections that follow). The range and step of each scenario was iteratively tuned during the analysis phase to find a combination that illustrates the nature of the scenario in a fair, yet clear light.

4.1.4 Measured Outputs

The following outputs were either calculated or measured and captured in the model database:

Table 5: Measured Outputs

Nr	Measurement Name	Description
1	Input Variable	Injected input variable
2	LINEST	Gradient of Linear Regression fit curve
3	Correlation	R^2 (regression coefficient)
4	IRR	Internal Rate of Return (%) of the ERP implementation
5	ROI	Return on Investment period (years)
6	Rev-CAGR	Revenue Compound Annual Growth Rate (over the 12 year modelling period)
7	Prof-CAGR	Profit Compound Annual Growth Rate (over the 12 year modelling period)
8	Total ERP Cost	Total cost (license and other) incurred over the lifetime (12 years) of the model
9	Total ERP Saving	Total saving realised from the ERP over the lifetime (12 years) of the model
10	Net Effect	Total ERP Saving - Total ERP Cost
11	Total Revenue	Total (cumulative) revenue of the firm over the lifetime (12 years) of the model
12	Total Profit	Total (cumulative) profit of the firm over the lifetime (12 years) of the model
13	ERP Cost as % of Firm Profit	The total ERP Cost expressed in terms of a % of the cumulative firm profit
14	Median ERP Cost as % of Firm profit	Statistical median of measurement 13
15	Average Correlation	Statistical average of measurement 3 (R^2)
16	Median Correlation	Statistical median of measurement 3 (R^2)

The primary measurement of interest was the correlation coefficient (R^2 – measurement 3 in the table above). In addition to this, the correlation between each scenario's input variable and R^2 was also measured, in effect getting the "correlation of the correlation". This measurement indicates the robustness of the correlation to the selected input variable.

If the correlation produces a deterministic (or predictable) response to differing levels of the input variable, this indicates that the license model has a robust response to varying conditions of the input variable.

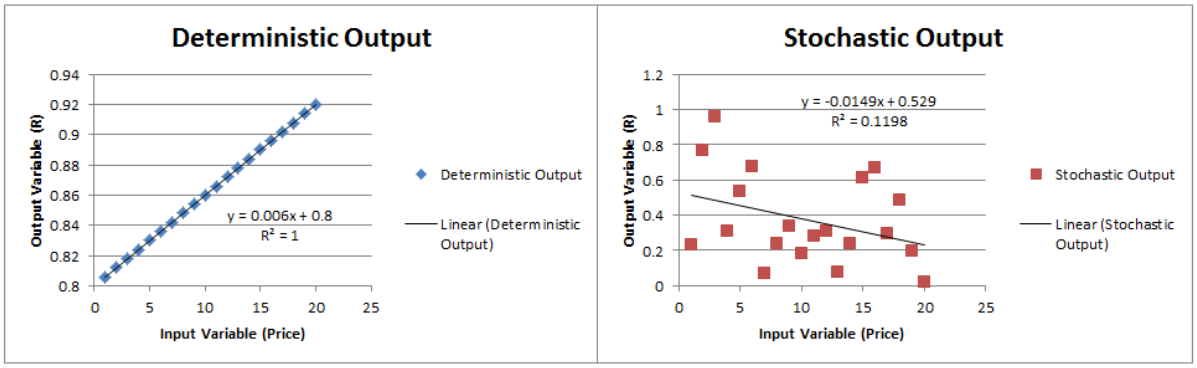

Figure 19: Deterministic (Robust) vs. Stochastic (Weak) correlation

If the correlation however produces a stochastic (non-deterministic) response to varying levels of the input variable, this indicates that the license model shows a strong correlation between ERP Cost and Saving under "ideal" conditions but that this correlation weakens under stressed conditions such as very low profit margins.

In addition to reporting on the robustness of the correlation, some of the other measurements will also be plotted against the input variable and/or themselves. Wherever there is an interesting trend that emerges from the other variables, this will be illustrated and discussed in the highlight results.

4.1.5 Summary Results

Table 6: Results Summary

Nr	Name	Type	Average Correlation	Median Correlation	Median ERP Cost/Firm Profit	Correlation Trend	Correlation Direction	ERP Cost vs. Value Trend	ERP Cost vs. Value Direction	Interesting Trends
1	Raw Material Cost below Sales Price	Market/ Economic	0.990	0.993	0.73%	Quadratic	Declining	Constant	Flat	Correlation drops sharply at very low margins
2	Order Size	Market/ Economic	0.996	0.997	2.84%	Sigmoid	Tending to 1	Linear	Increasing	Economies and Diseconomies of scale visible in profit curve
3	Base Price of Bread	Market/ Economic	0.993	0.995	1.74%	Sigmoid	Tending to 1	Linear	Increasing	ERP always yields >0 Net Effect, even when firm is not profitable
4	Outsource Baking Cost	Market/ Economic	0.995	0.996	2.70%	Piecewise Constant	Increasing	Sigmoid	Tending to R55M	This is the only scenario where the Cost vs. Value has a non-linear response
5	Base License Cost of ERP	ERP Pricing	0.993	0.993	2.97%	Linear	Declining	Constant	Flat	The only input variable that yielded all linear responses in the test outputs
6	ERP Volume Spend License Fee	ERP Pricing	0.997	0.999	8.56%	Sigmoid	Tending to 1	Constant	Flat	The ROI and IRR measures are very sensitive to this input and soon drop off the chart altogether
7	Maintenance Cost	Market/	0.997	0.997	2.74%	Sigmoid	Tending to 1	Constant	Vertical	Increasing maintenance cost has no effect on ERP cost,

		Economic								but has a strong effect on ERP saving
8	User License Cost	ERP Pricing	0.987	0.986	4.59%	Quadratic	Declining	Constant	Flat	Increasing user license cost drives down Cost vs. Value correlation in a Quadratic shape
9	Competitiveness Bonus	Implementation/ERP	0.995	0.994	1.73%	Quadratic	Declining	Constant	Vertical	At very low values of the input variable, the IRR and ROI are not viable
10	Inflation	Market/Economic	0.998	0.999	0.92%	Sigmoid	Tending to 1	Linear	Increasing	Higher inflation rates yield higher IRR and lower ROI values
11	Only user license (Order Size var.)	Experimental	0.981	0.983	1.53%	Stochastic	Increasing	Linear	Increasing	This is the only scenario where the correlation between Cost vs. Saving has an erratic, stochastic response

The “summary results” section is intended to serve as a sort of “recap” or “quick reference guide” that a reader may consult when jumping between sections of the results, or looking up a specific scenario or trying to find a trend in the results.

4.1.6 Results

4.1.6.1 Scnenario1: Raw material cost below sales price

The ERP Saving has a flat response across the input range of the variable. In other words, as the input costs decreases (growing the profit margin) the ERP cost increases, however the ERP saving stays flat across the input range of the variable.

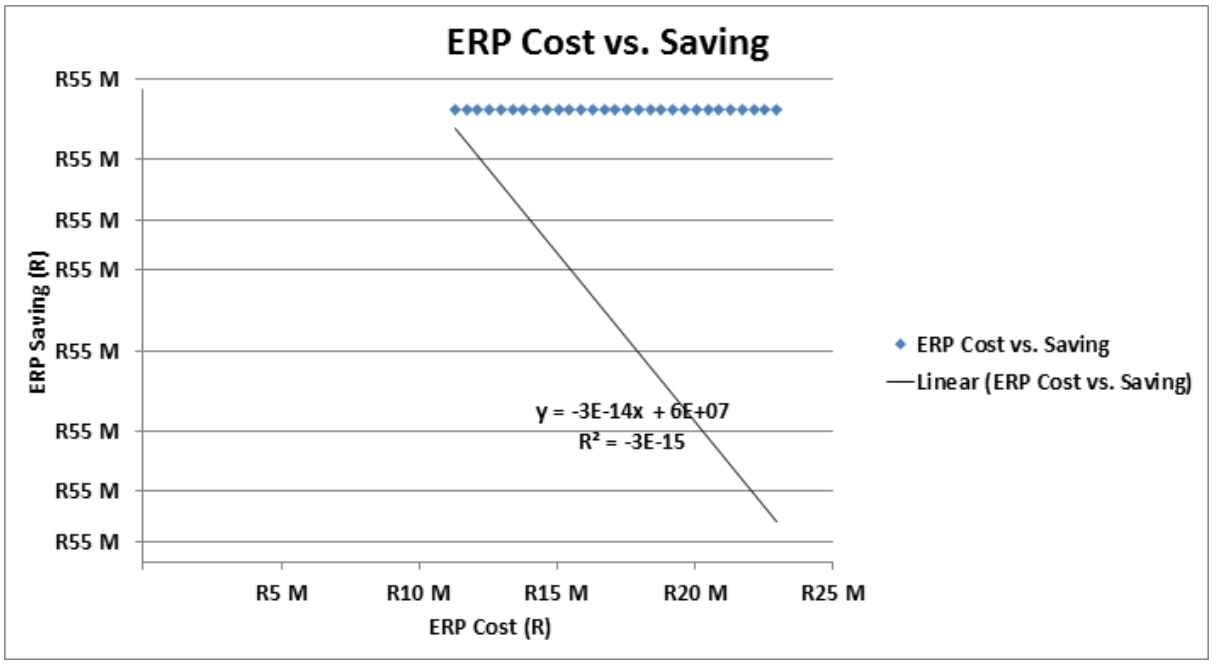

Figure 20: ERP Cost vs. Saving

Although the ERP Cost is strongly correlated to the ERP Saving throughout the range of the input variable, this correlation starts to drop (exponentially) as the input cost approaches zero. This indicates that higher margins achieved by the firm will actually lower the correlation between ERP cost and ERP savings.

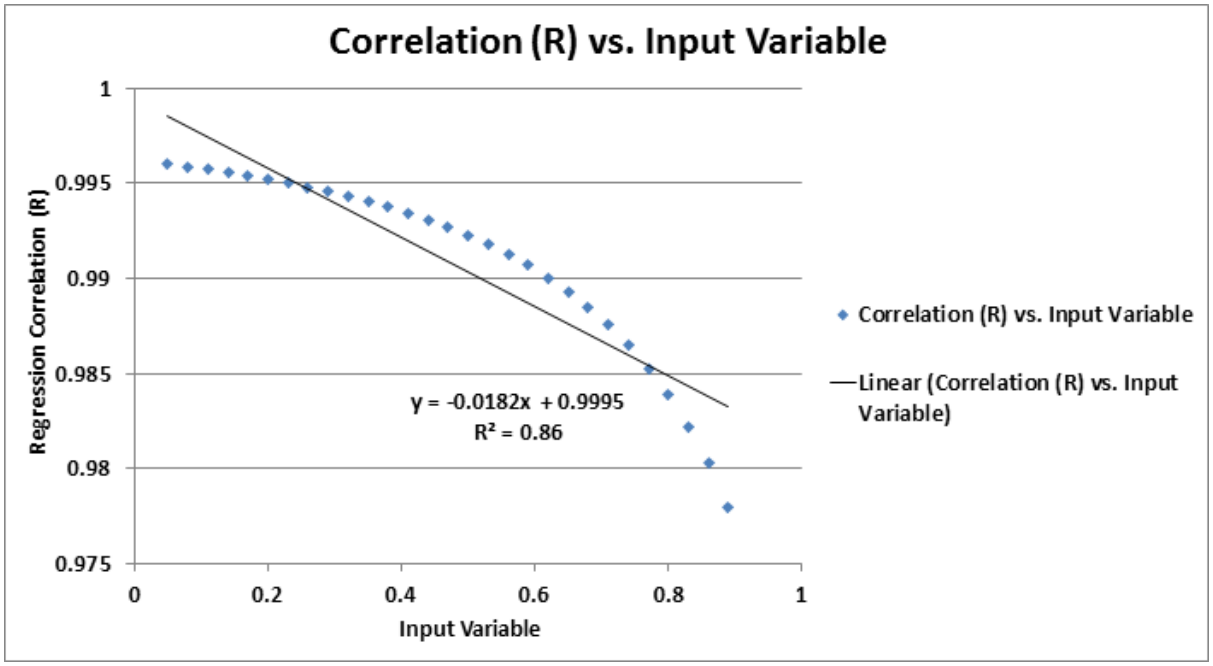

Figure 21: Correlation (R) vs. Input Variable

Another interesting point to note is that throughout the range of the input variable, the ERP seems like a sound investment with an IRR of greater than 20%. This is despite the fact that the firm is loss-making for the first two steps of the variable and only starts to make a decent profit a third of the way through the range.

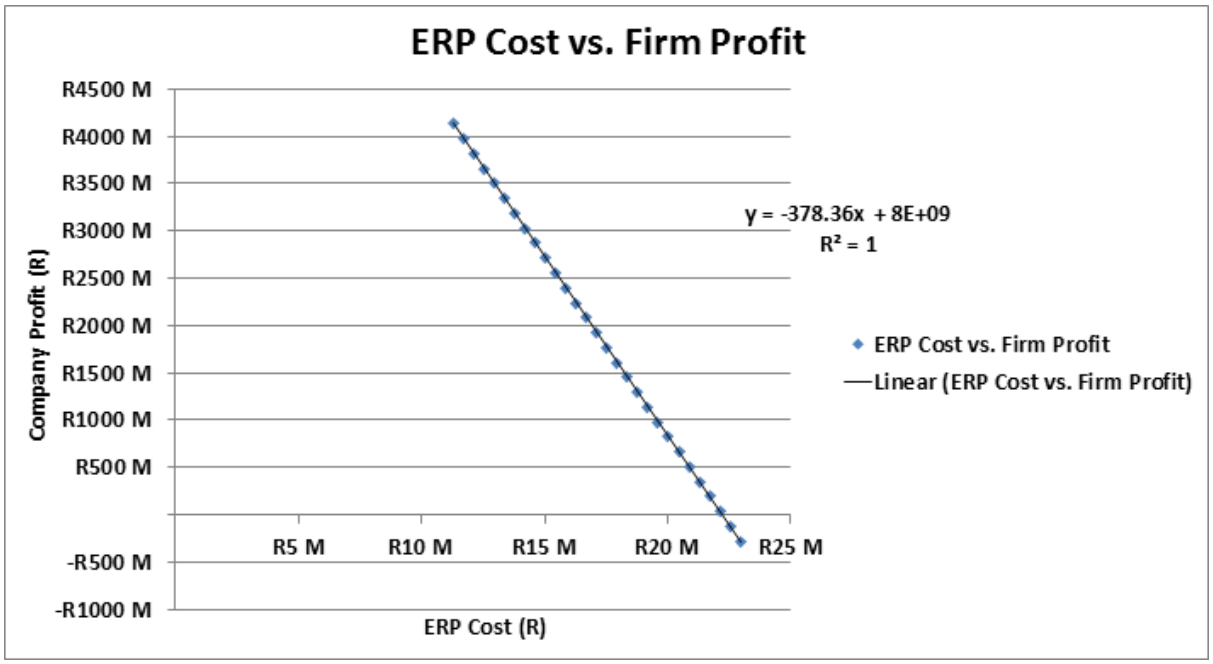

Figure 22: ERP Cost vs. Firm Profit

4.1.6.2 Scnenario2: Order Size

The most interesting point about this scenario has nothing to do with ERP licenses, but rather has everything to do with the validity of the model as a representation of an actual economic firm. Exactly as is depicted in every "Economics 101" textbook, the model illustrates the profit maximisation principle with economies and diseconomies of scale.

As can be seen on the chart below, for the first few steps of the increasing order sizes the firm's profit increases steeply (economies of scale) before slowing down. After the maximum profit point, the profit starts to decline rapidly with further increasing orders until it plunges below zero.

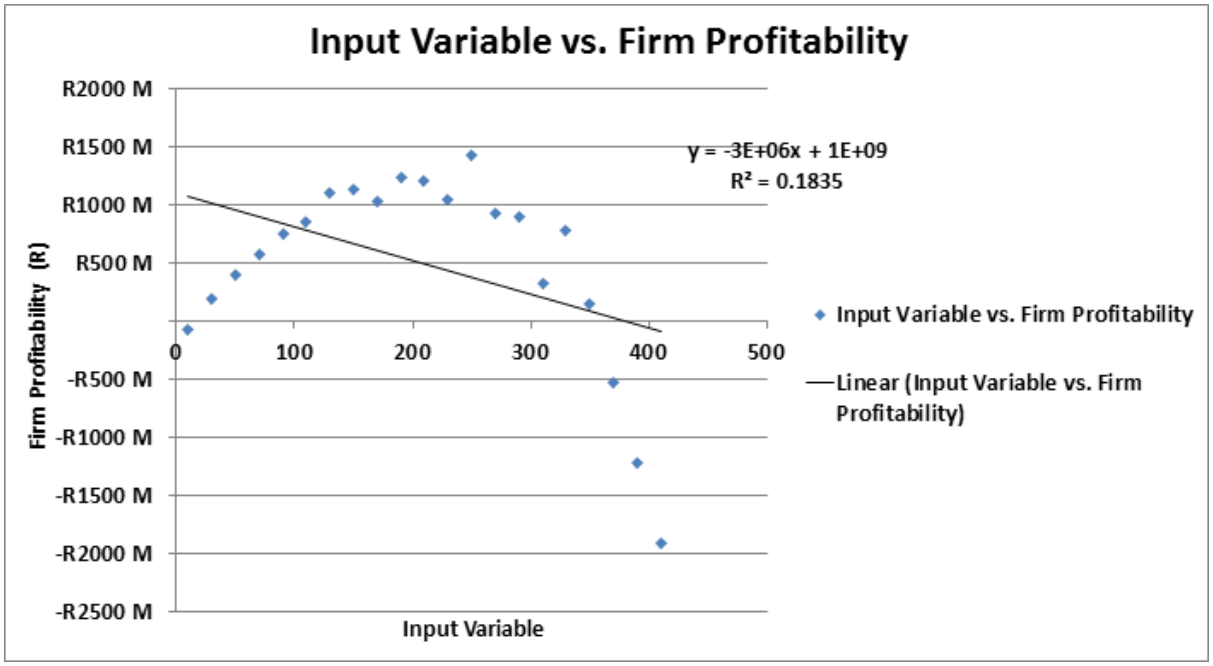

Figure 23: Input Variable vs. Firm Profitability

4.1.6.3 Scnenario3: Base Price

The "base price of bread" scenario yielded very interesting results in that almost all the responses tested against the input variable produced a completely linear response.

The correlation between ERP Cost and ERP Saving remained very high across the range of the input variable with the correlation actually increasing as the bread price increased.

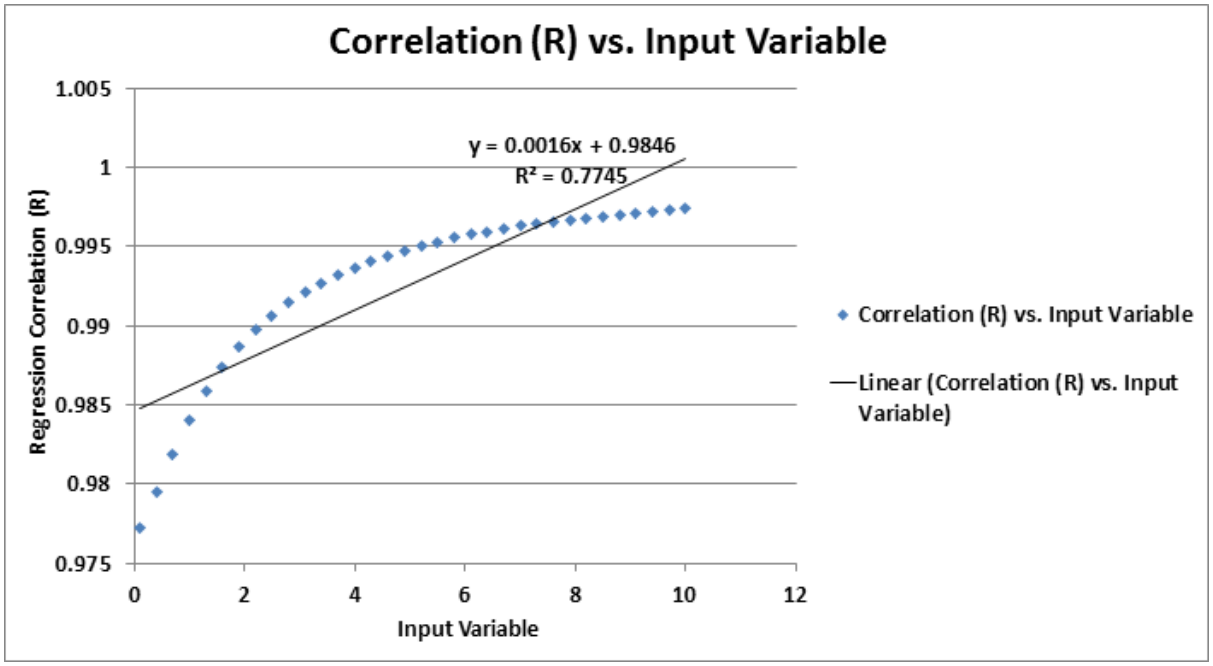

Figure 24: Correlation (R) vs. Input Variable

4.1.6.4 Scnenario4: Outsource Baking Cost

This scenario yielded interesting results that speak to the artificial intelligence that has been built into the baseline model.

At very low values of the input variable, it is cheaper for the bakery to utilise outsource baking than to produce the bread itself. This causes the model to alternate between the decision to insource/outsource some part of the production order. The result yields certain step discontinuities in the responses of the some of the output variables.

Throughout the range of the input variable, there is very little effect on the IRR and no measurable effect on the ROI.

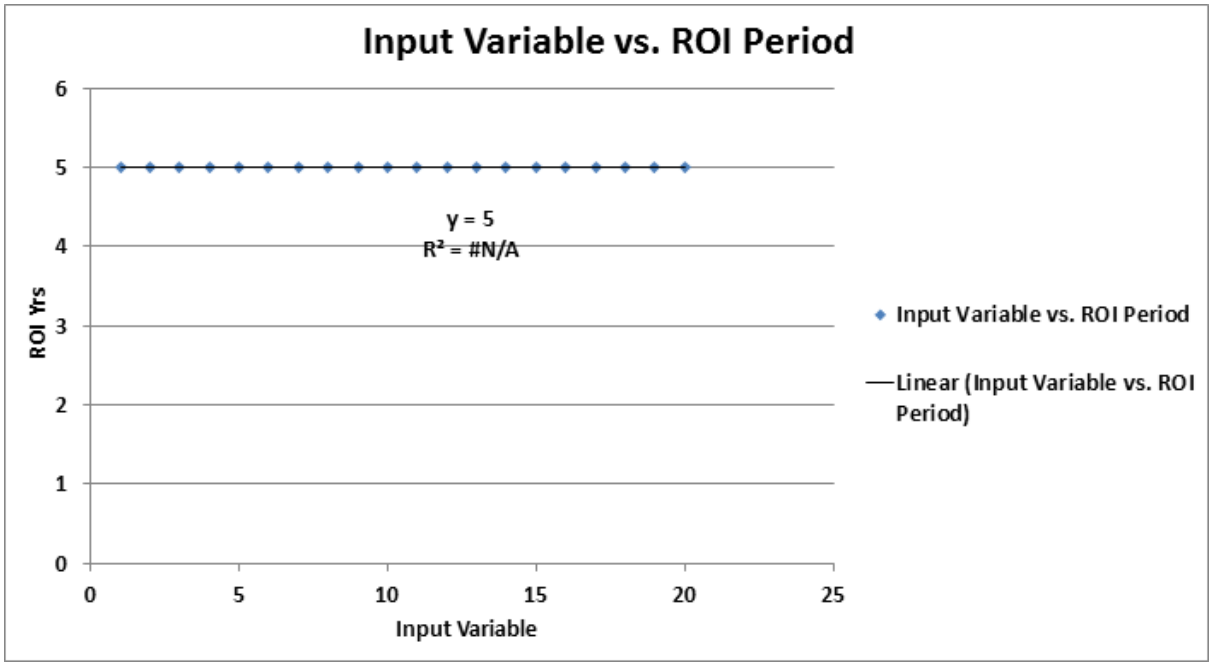

Figure 25: Input Variable vs. ROI Period

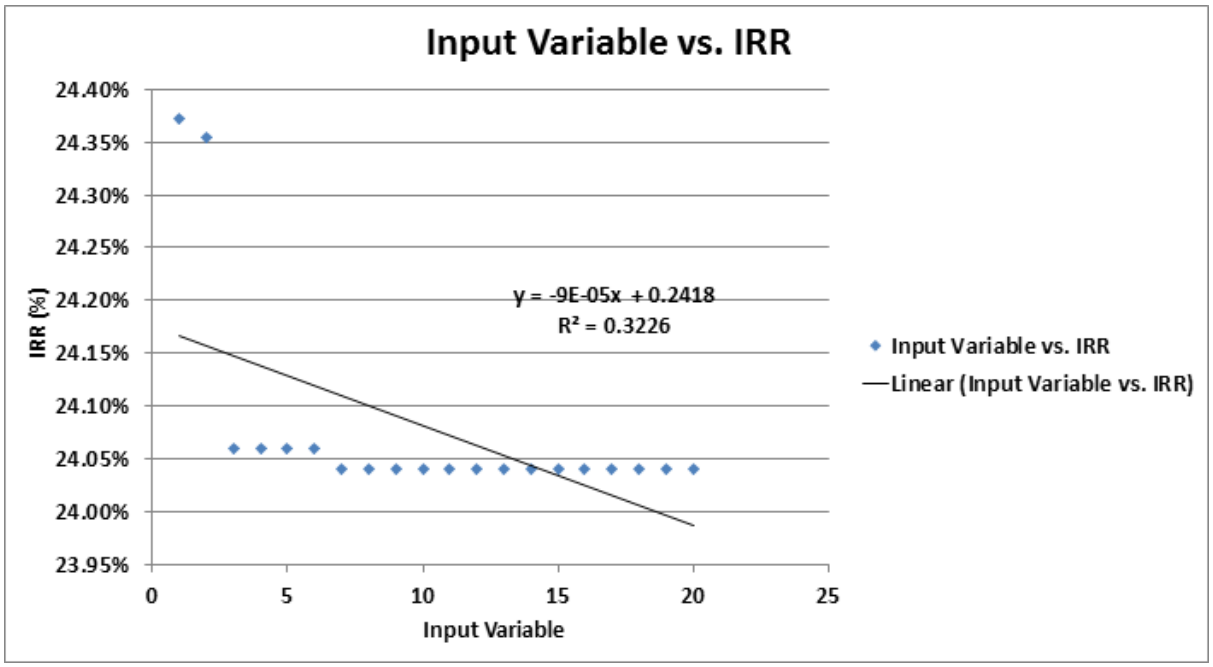

Figure 26: Input Variable vs. IRR

The correlation between ERP Cost and ERP saving is very high with little change in response to the actual input variable.

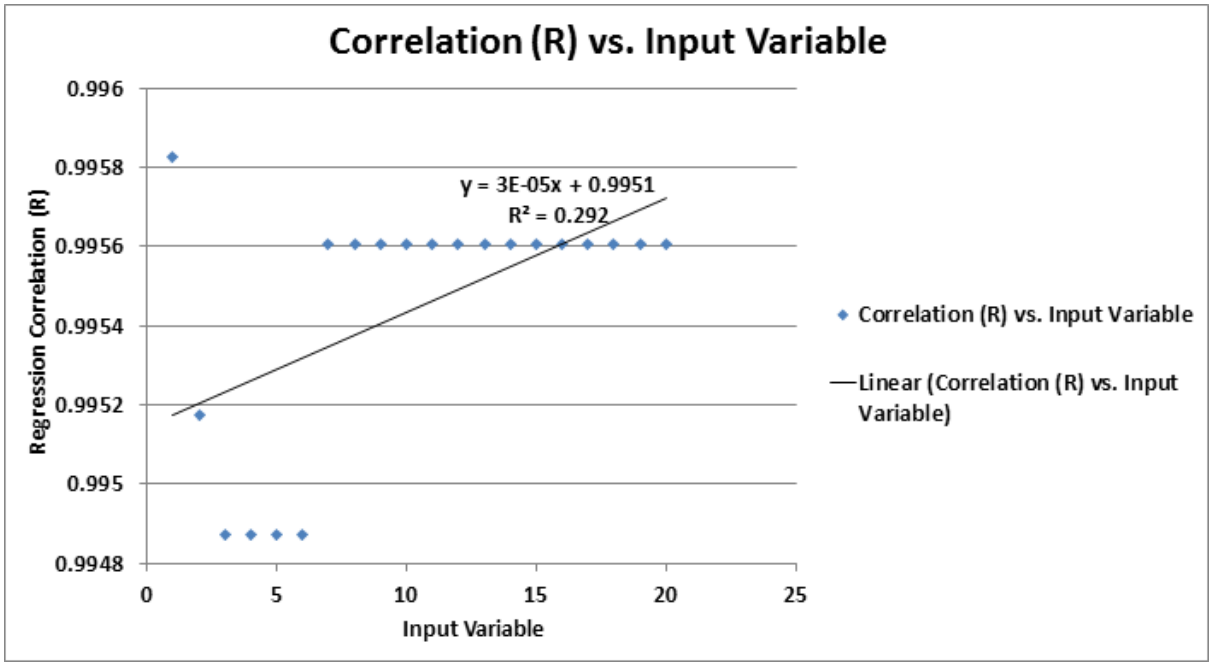

Figure 27: Correlation (R) vs. Input Variable

At each one of the discontinuities on the chart, the model made a new decision about using outsource baking or installing additional capacity. However, once the model has settled on a new level, it generally stays on that level for various consecutive steps of the input variable.

4.1.6.5 Scnenario5: Base License Cost of ERP

This is the first of the scenarios that is focussed on adjusting components within the ERP license model itself as opposed to the market conditions that the firm finds itself in.

As expected, the ERP Saving would have a completely flat response to changing the ERP Base License cost. In other words, the various levels of the input variable only causes the ERP license to become more expensive without adding any additional value (savings).

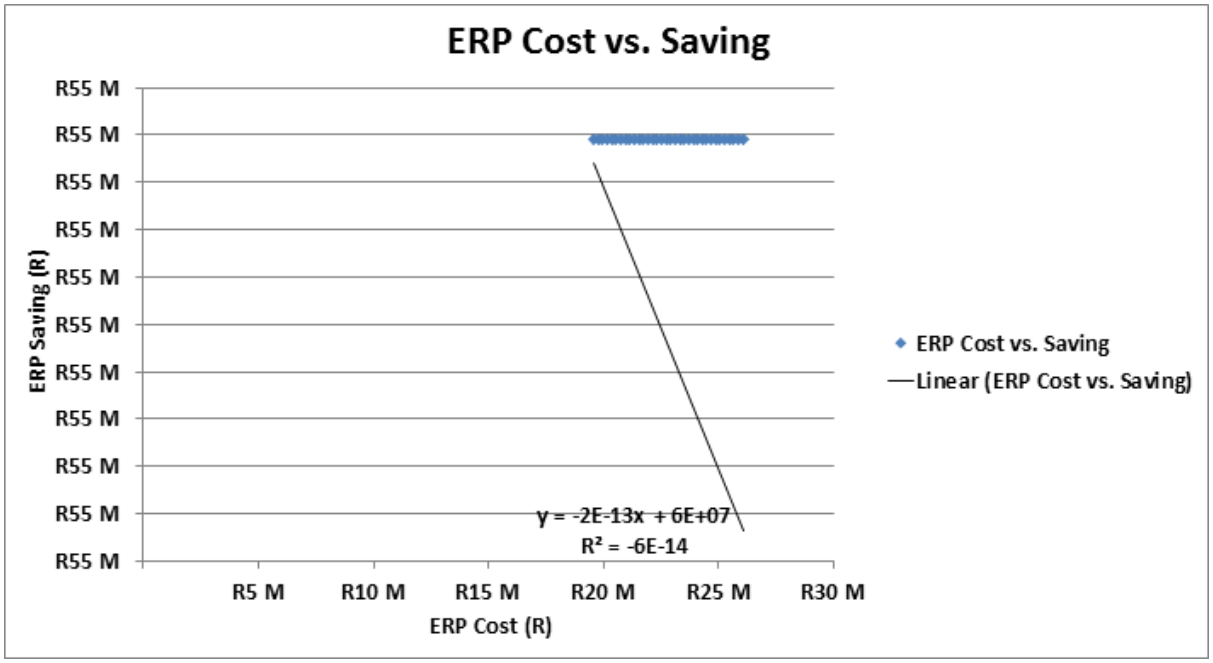

Figure 28: ERP Cost vs. Saving

An interesting point to note was that although the base license cost of the ERP was increased tenfold across the range stepped through in the scenario, the overall cost of the ERP (expressed as a percentage of the firm profit) only increased 1% from 2.5% to 3.5% (which remains low overall).

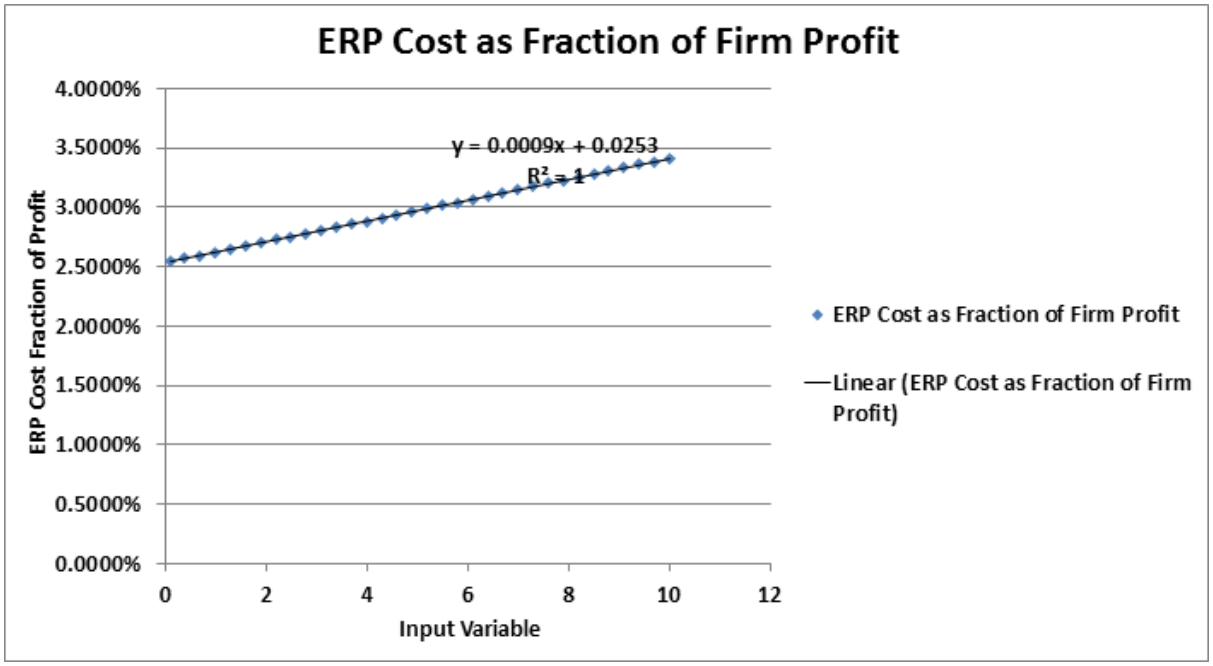

Figure 29: ERP Cost as Fraction of Firm Profit

In contrast however, the IRR of the ERP project decreases significantly from 25% to almost 10% across the range of inputs, making it a very unattractive investment.

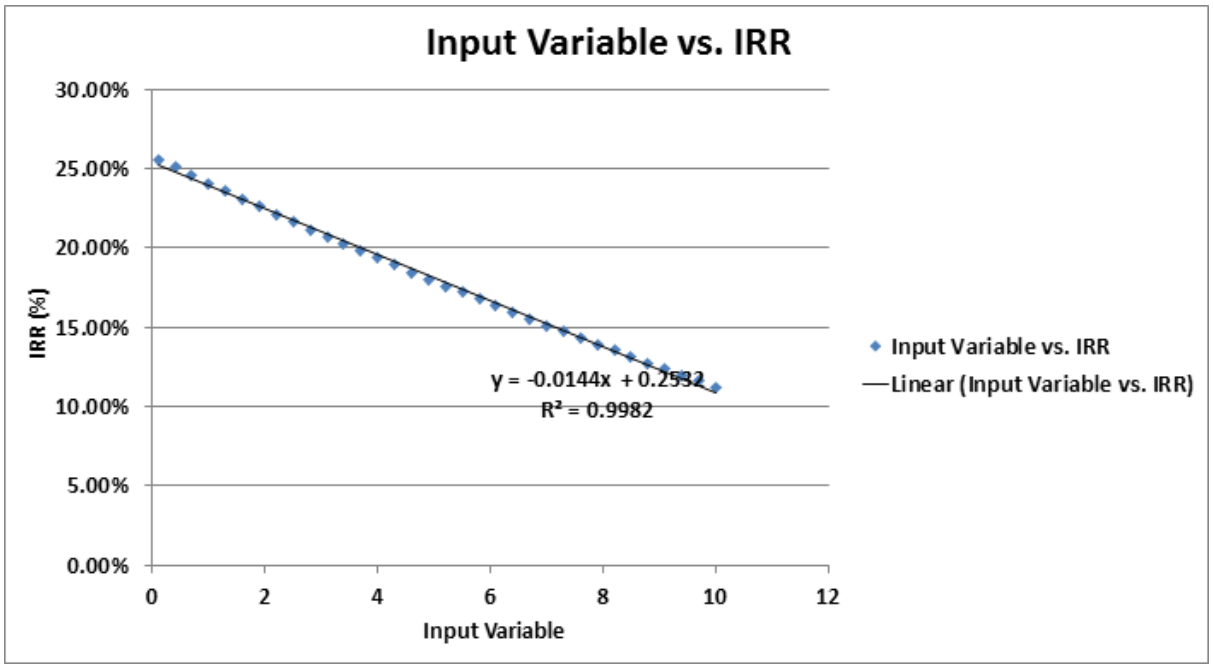

Figure 30: Input Variable vs. IRR

4.1.6.6 Scnenario6: ERP Volume Spend License Fee

Again in this scenario ("Spend Volume"), as with the other "license-focussed" scenarios; changing a component of the overall license model yields a completely flat response in the ERP Saving.

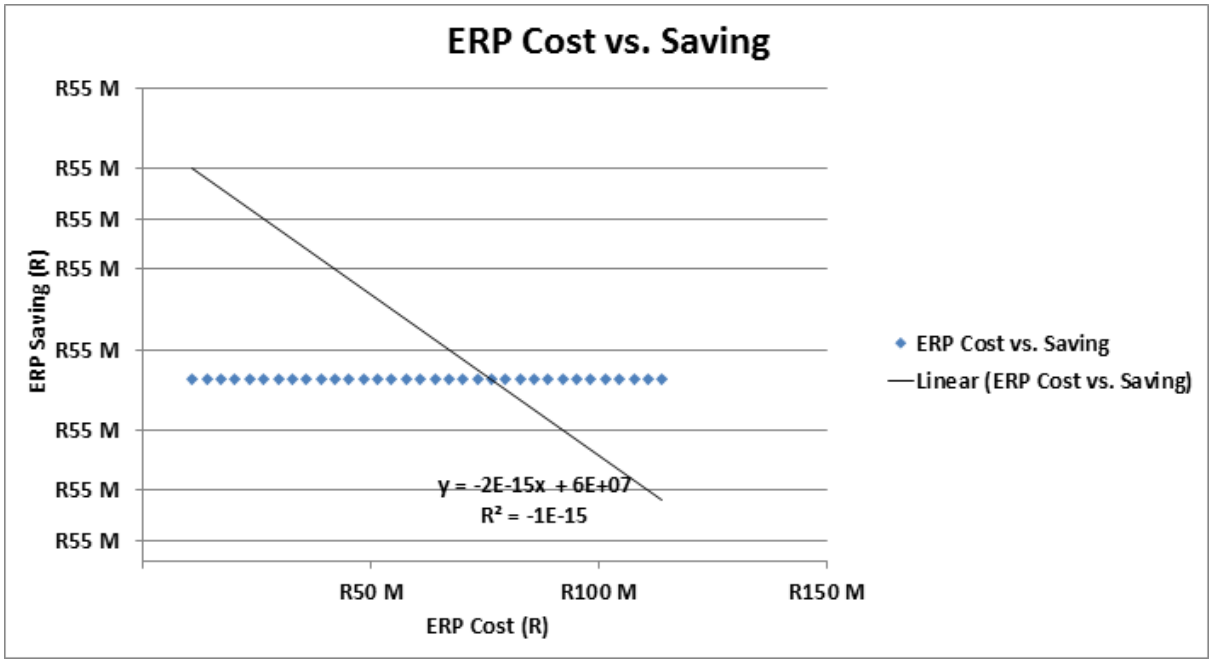

Figure 31: ERP Cost vs. Saving

This scenario is however the first scenario that sees the ERP Net Effect dip below zero. In other words, the ERP Saving decreases so much that the overall ERP cost becomes larger than the ERP Saving.

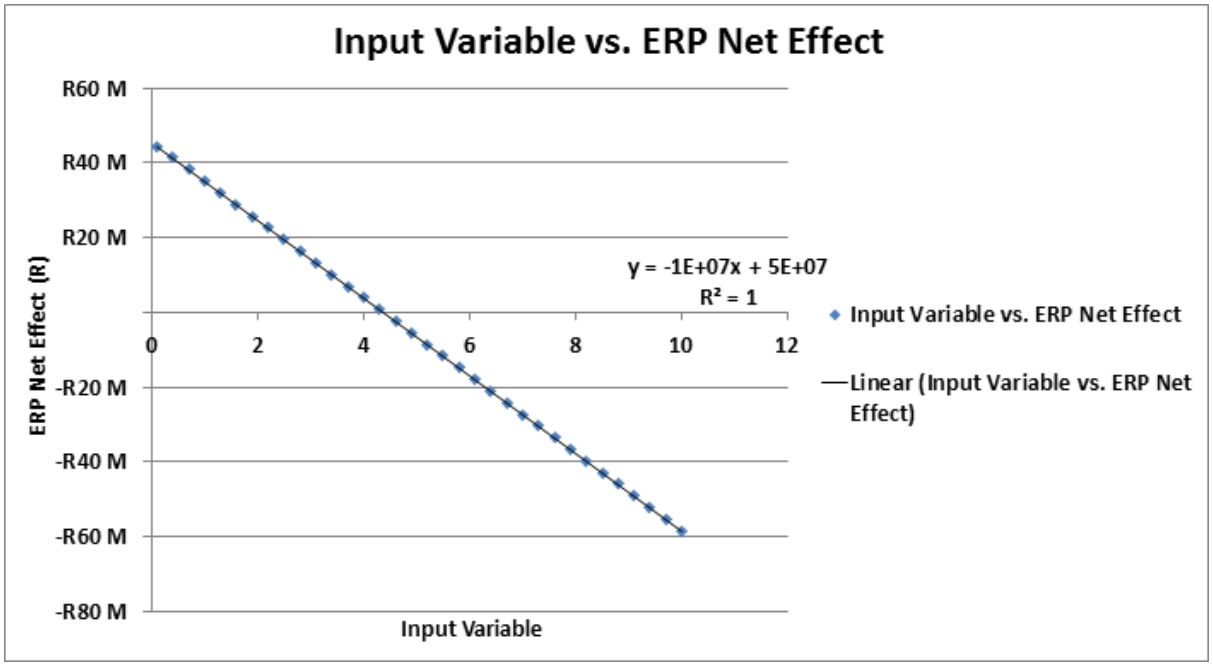

Figure 32: Input Variable vs. ERP Net Effect

Despite the drop in ERP Saving, the correlation between ERP Cost and ERP Saving actually increases over the range of the input variable towards a correlation of 1.

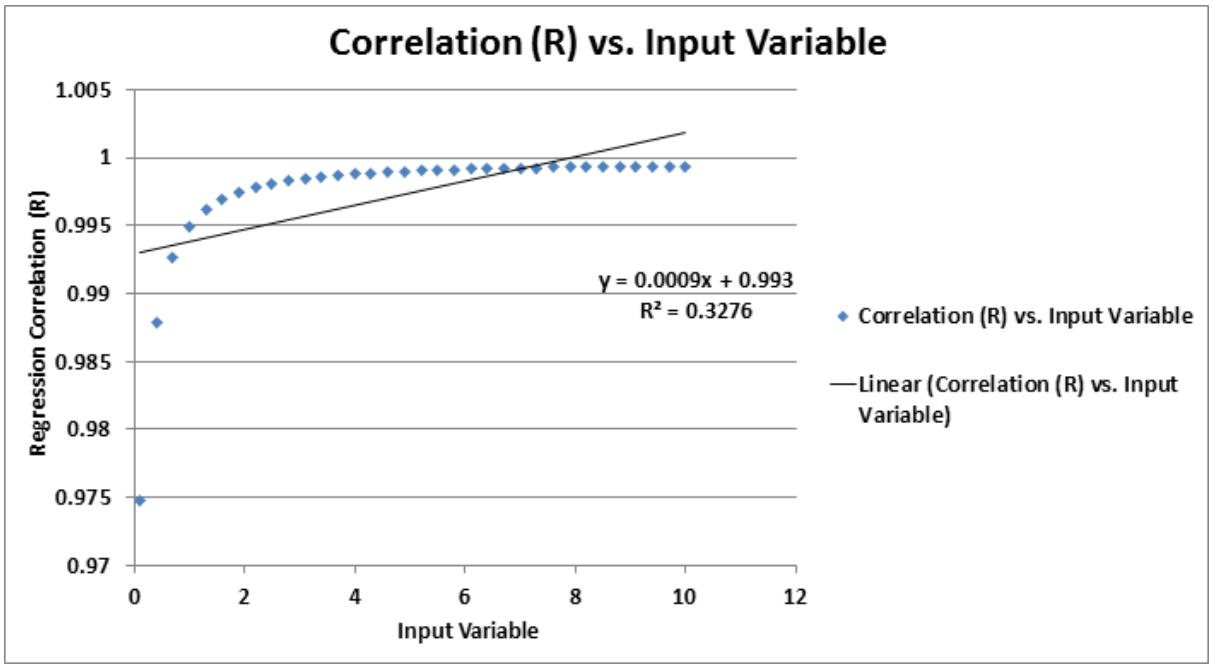

Figure 33: Correlation (R) vs. Input Variable

This is intuitive since the increase in the variable component of the license drowns out the fixed cost (base license).

4.1.6.7 Scnenario7: Maintenance Cost

The reduction in maintenance cost ("Maintenance Saving") that is realised through the use of the ERP can be seen as one of the "free" benefits associated with the ERP. This implies is that the actual level of saving realised does not affect the overall cost of the ERP. To this extent, the input variable yields a flat (or in this case a vertical) response to the input variable.

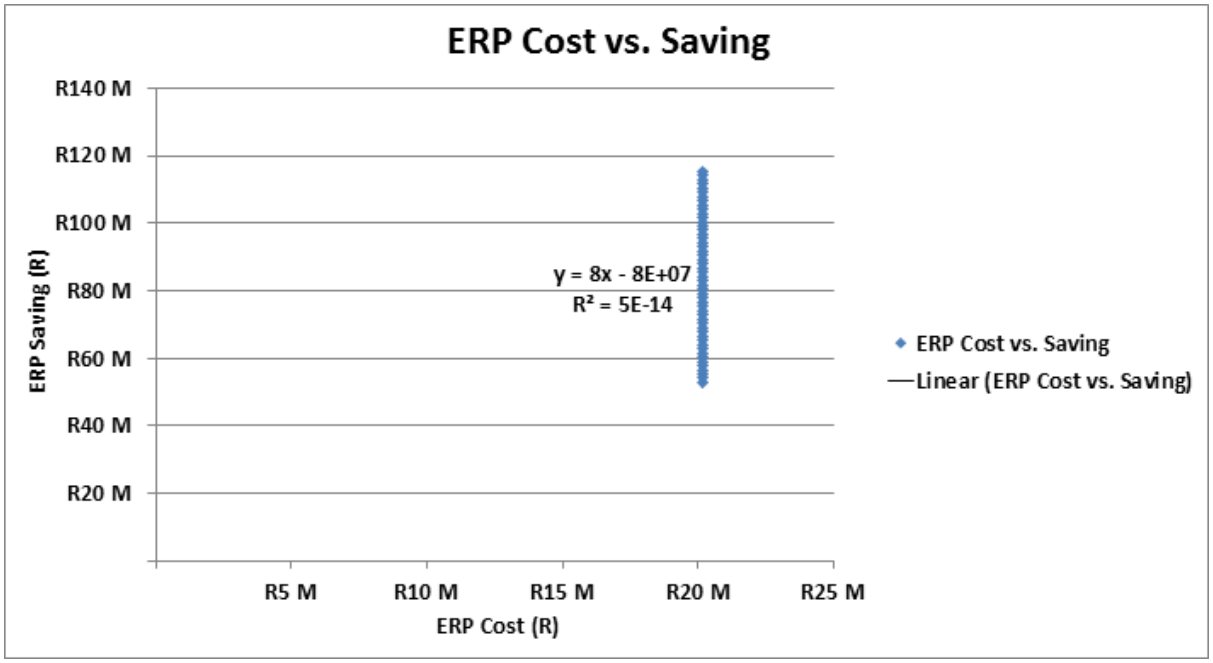

Figure 34: ERP Cost vs. Saving

The rest of the measured output variables yield a predictable (linear) response to the input variable.

Although the correlation between ERP Cost and ERP Saving remains highly correlated across the range of the input variable, there is a definite increase in this correlation as the maintenance cost increases.

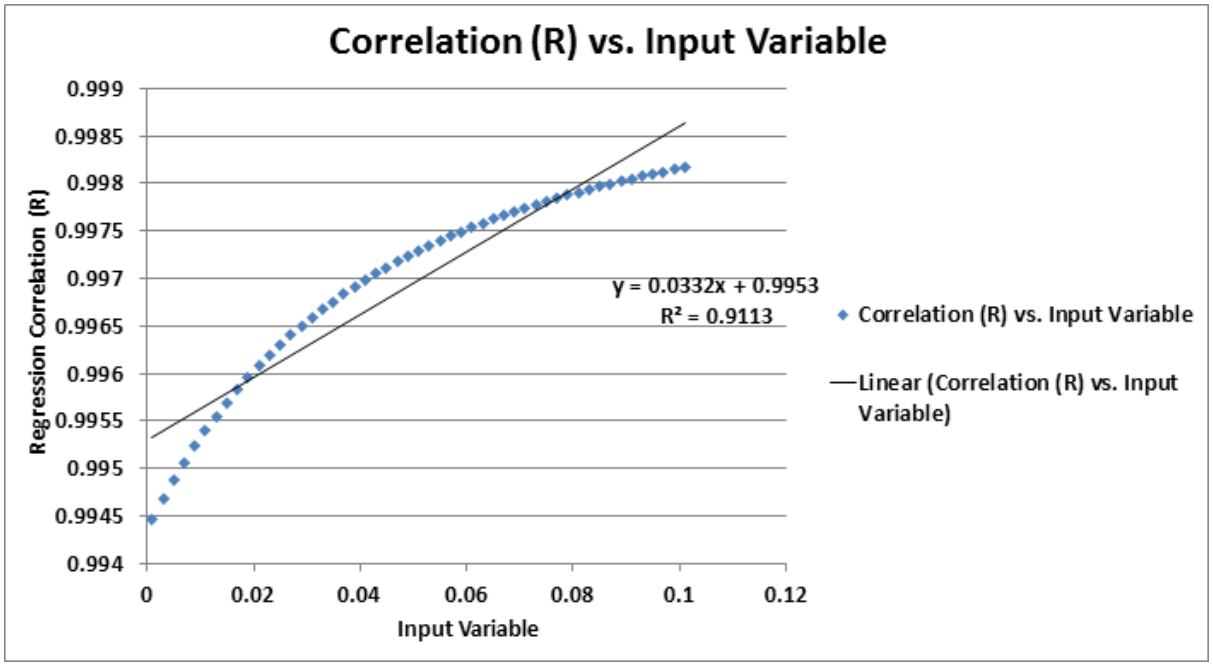

Figure 35: Correlation (R) vs. Input Variable

4.1.6.8 Scenario 8: User License Cost

The "User License Cost" scenarios (as with the other license cost scenarios) yield a flat response in the ERP Saving across the input range for the input variable.

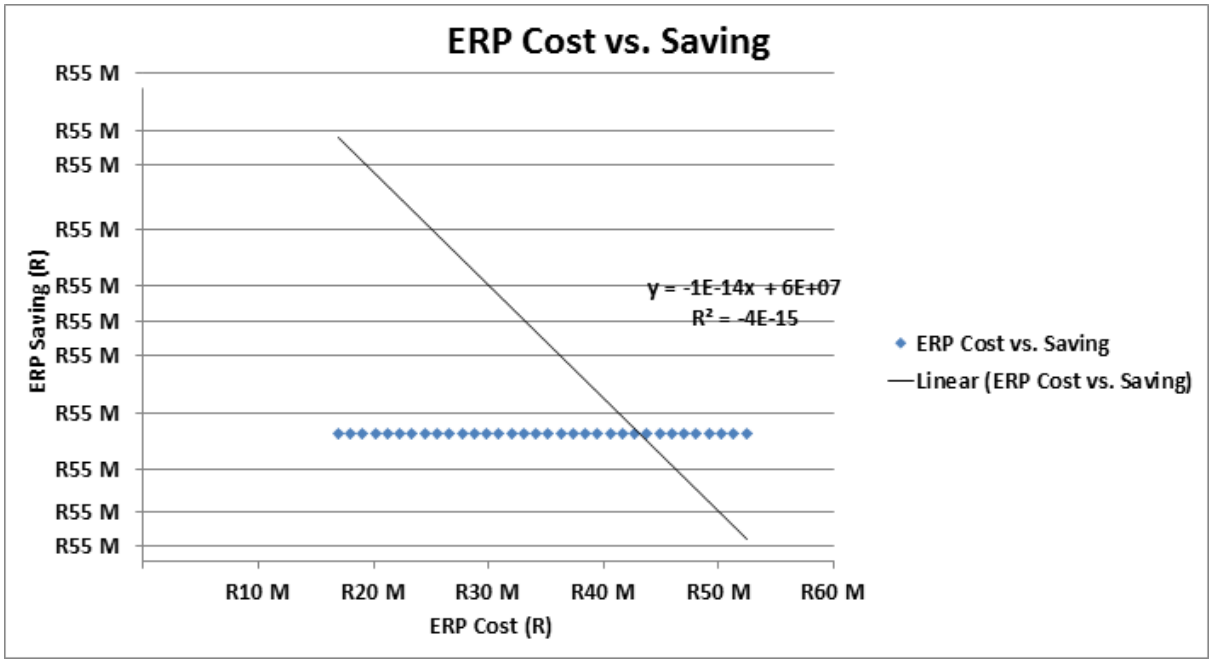

Figure 36: ERP Cost vs. Saving

The other measured output variables yield a predictable (linear) response across the range of the input variable.

What is interesting about the "User License" scenario (as opposed to the "Spend Volume" scenario) is that the correlation between the ERP Cost and the ERP Saving is actually a decreasing function across the range of the input variable.

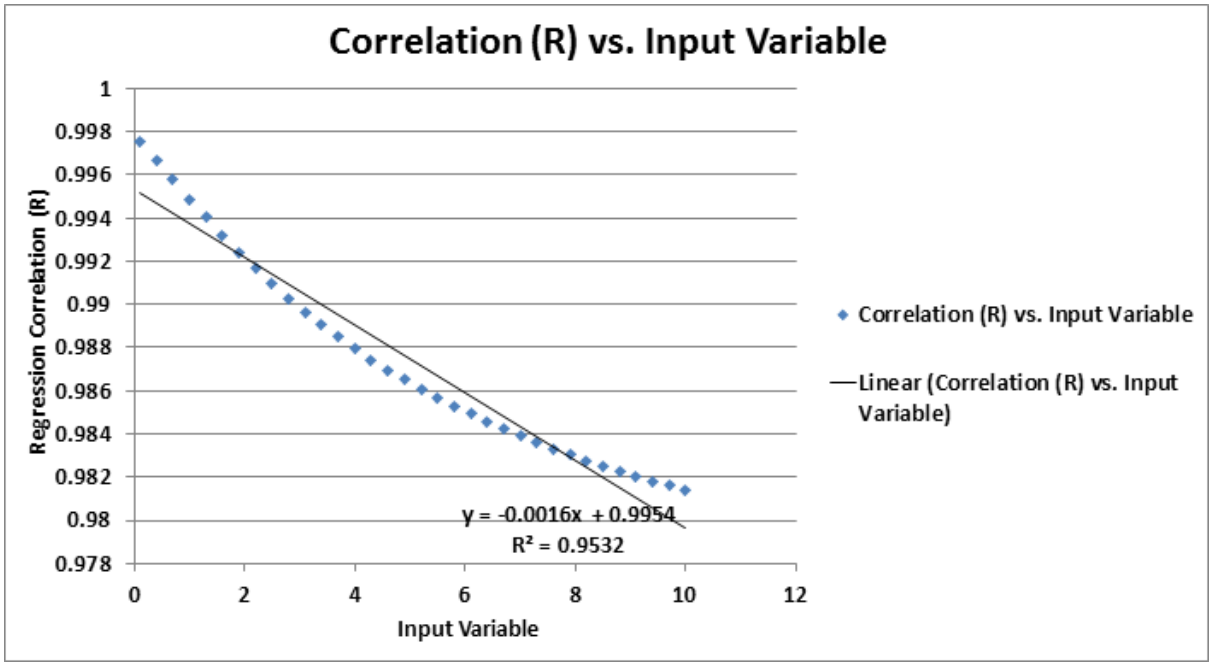

Figure 37: Correlation (R) vs. Input Variable

4.1.6.9 Scenario 9: Competitiveness Bonus

As with the other "free benefits" of ERP, the ERP Cost is not affected by the input variable at all.

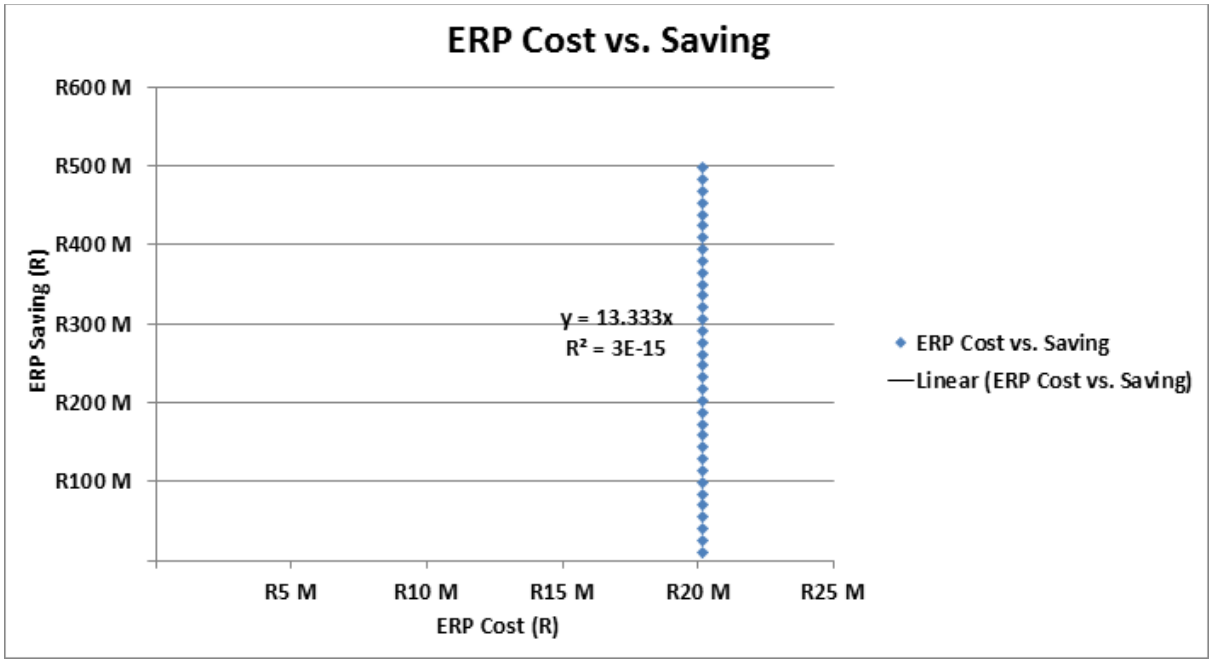

Figure 38: ERP Cost vs. Saving

The other interesting thing to note is that without the competitiveness bonus (or at very low levels), the ERP Net Effect actually dips below zero.

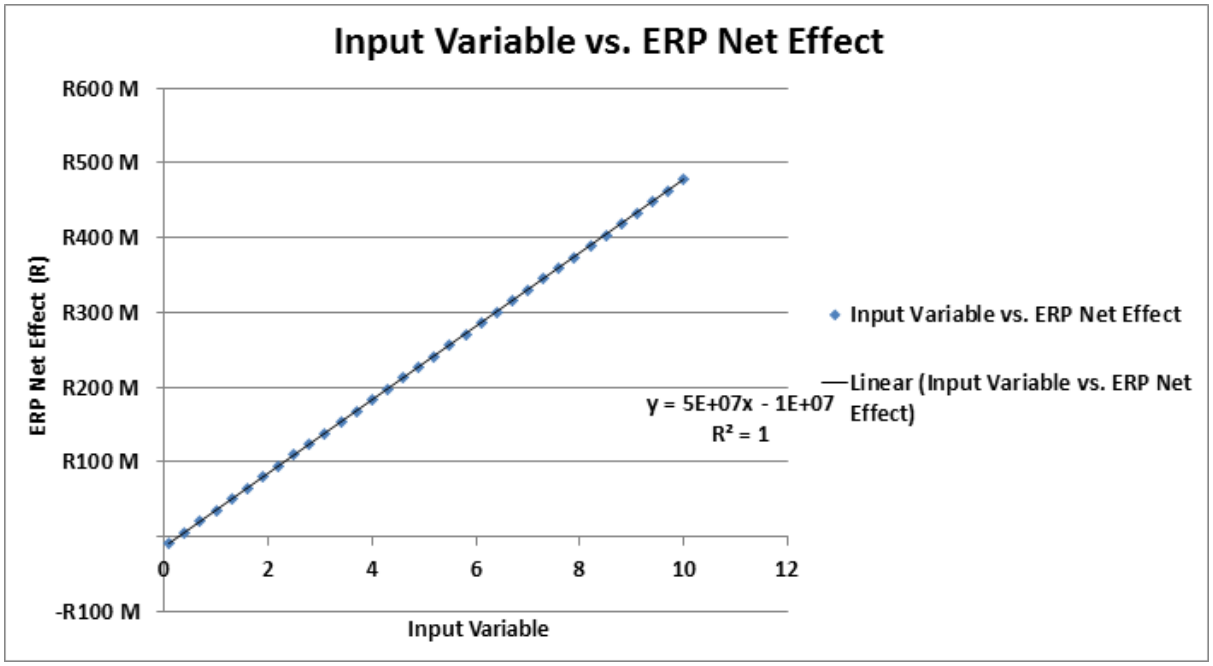

Figure 39: Input Variable vs. ERP Net Effect

Only after the variable reaches 0.4 does the firm start to become profitable over the measurement period.

This unfortunately implies that if a company is not able to realise any of the intangible benefits, the ERP will end up being a pure cost (in this model at least).

The other interesting trend to observe from this scenario is that the correlation between the ERP Cost and ERP saving actually declines as the amount of intangible benefits increase.

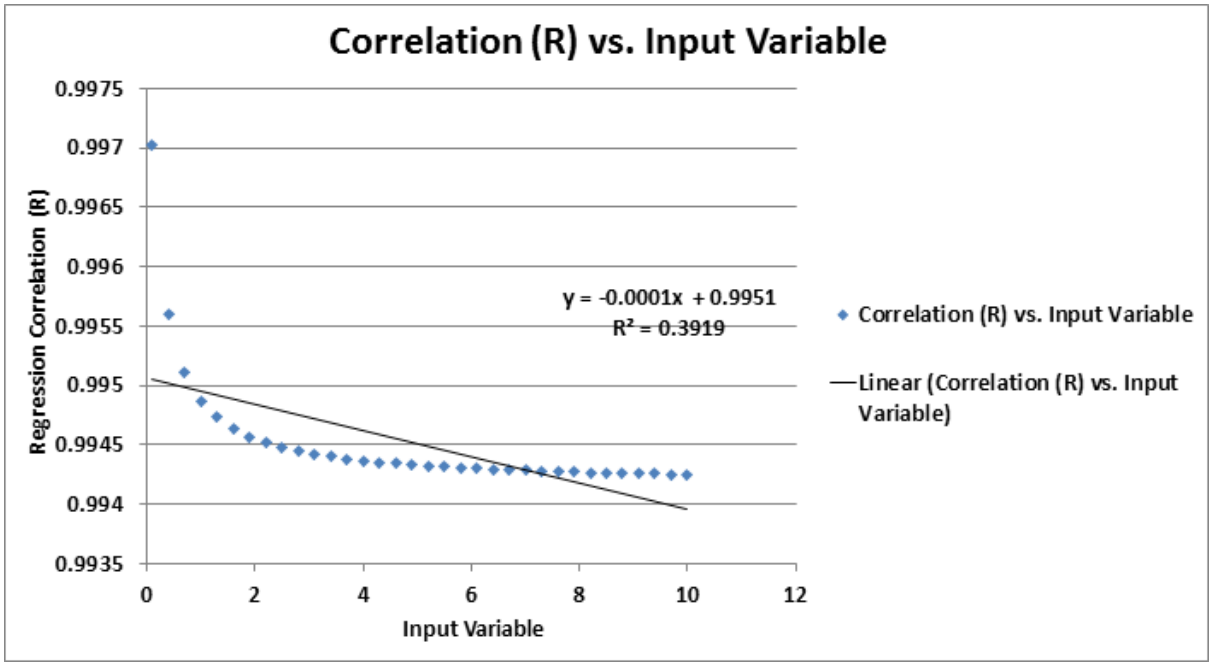

Figure 40: Correlation (R) vs. Input Variable

4.1.6.10 Scenario 10: Inflation

The first interesting trend that is visible from this scenario is the fact that (from this model's perspective) elevated inflation seems to be beneficial for bread producers.

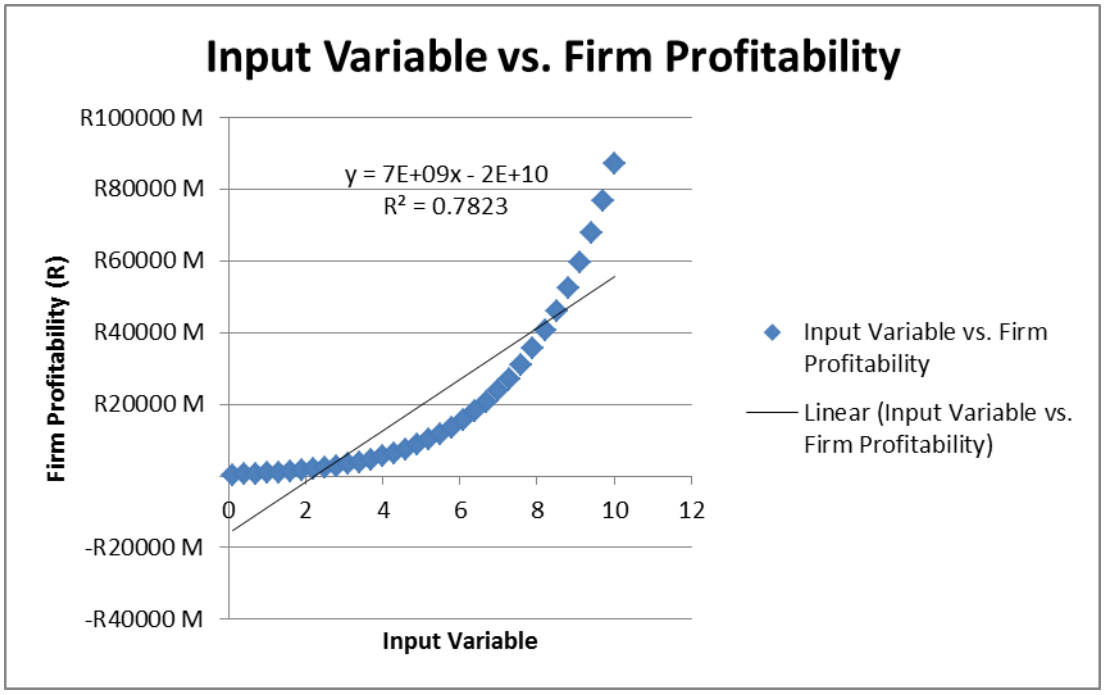

Figure 41: Input Variable vs. Firm Profitability

In reality, the situation will likely play out very differently under extreme inflationary conditions. Consumers will likely switch back to maize and other cheaper staple forms under highly inflationary conditions which will end up hurting bread producers. However, this shortcoming of the model is irrelevant, since the goal is to test the response of the ERP license model under different levels of inflation and not to test consumer sensitivity to inflation.

4.1.6.11 Scenario 11: Only user license (Order Size var.)

The most interesting trend to emerge from this experimental scenario is the fact that most of the measured output variables have very similar responses to Scenario 2, which was essentially the same Simulation with a Tier-1 license model.

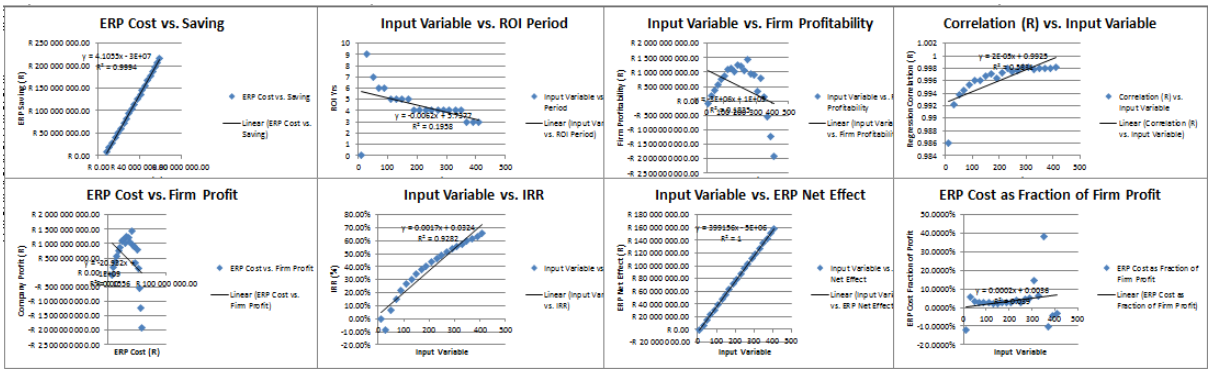

Figure 42: Scenario 2 - Order Size with Tier-1 License Model

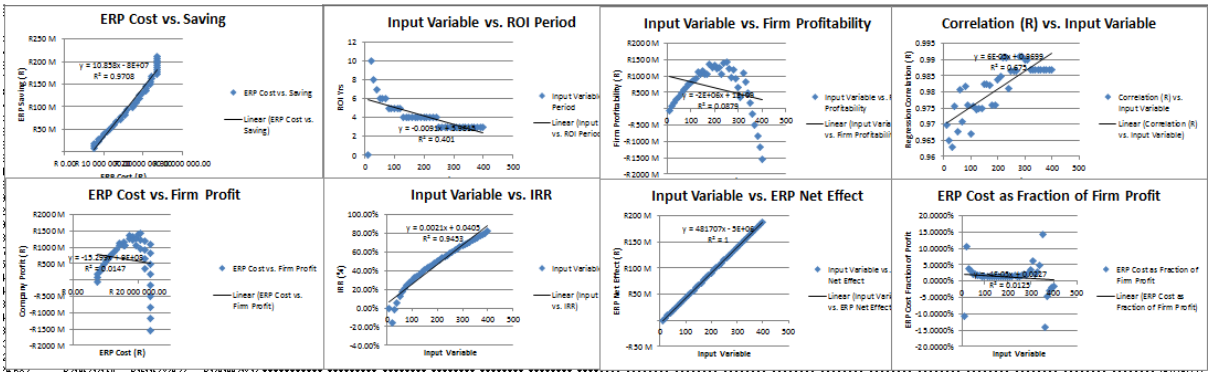

Figure 43: Scenario 12 - Order Size with Tier-2 License Model

Assuming that the high level of complexity built into Tier-1 ERP license models are supposed to align ERP Cost and Value, this result seems to suggest that the same (or very close to the same) result is possible with only user licenses.

The one measured output that showed a significantly different result over the range of the input variable was the level of “correlation” (between ERP Cost and ERP Saving). In the Scenario with the Tier-1 license model, this trend of the correlation exhibited a deterministic function (top half of a sigmoid curve tending to 1).

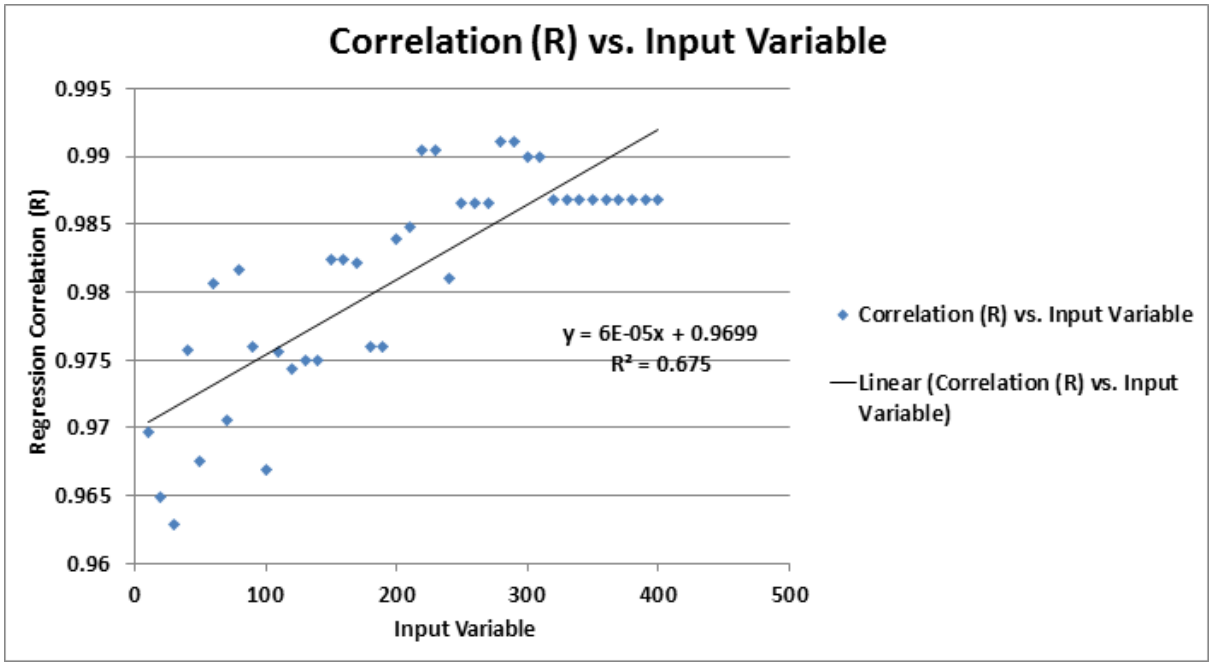

Figure 44: Correlation (R) vs. Input Variable

In this scenario, the correlation output variable exhibits a more randomised function that has a linear regression correlation coefficient of 0.675. This is not completely random, but certainly less deterministic than any of the trends observed in the correlation of the previous scenarios.

This apparent randomisation of the correlation could be attributed to the loss of measurement granularity that associated with the "User-License only" model. In other words, in a Tier-1 license model, every additional sales order or Rand spent would add (a tiny amount) to the license cost, whereas the "User-License only" license model would only add (a large amount) onto the license cost. However, it would only do so each time an additional user license is purchased.

The implication of this is that larger organisations (with more employees) should have a more closely correlated ERP Cost vs. ERP Saving than a smaller organisation with only one or two ERP users. This is ironic, seeing that smaller organisations typically have ERPs with simpler license models such as the "User-License only" model demonstrated above.

4.2 Conclusions

This chapter provided a summarial account of the computer simulation's results. For a full account of these results, the reader may consult the relevant Appendices.

The next chapter will discuss the implications of these results for the proposed hypothesis before concluding and providing direction for future research.

5 CONCLUSIONS AND IMPLICATIONS

The previous section presented the results from the model simulation as well as the qualitative field research.

This chapter aims to recap previous chapters briefly and then close with a discussion of the results.

Finally the discussion will lead to a conclusion and identification of potential future research that may build on the research that has been performed here.

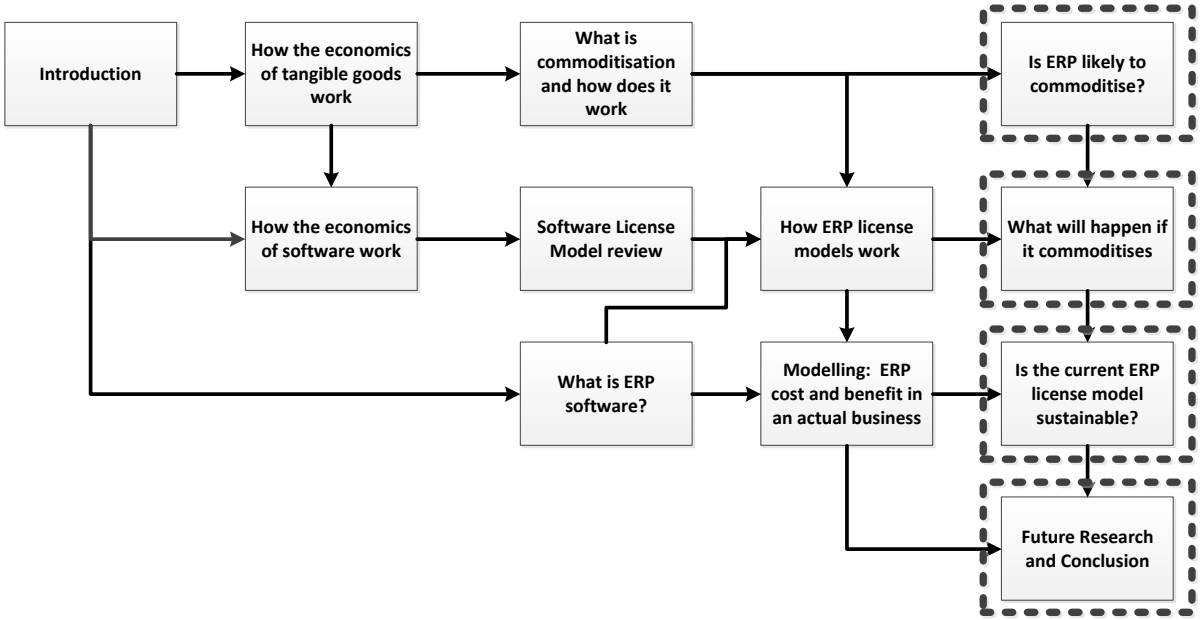

Figure 45: Document Map

5.1 Recap

5.1.1 Background

The aim of this research was ultimately to determine whether the current license models (Tier-1 and Tier-2) found in ERP software are sustainable.

This concept of sustainable simply means "whether it is able to carry on in its current form for years to come". However, the implication of sustainability carries a heavy burden since the license model is inextricably linked to almost every facet of the ERP industry in the same way that mortgages are

linked to the property market. Mortgage contracts are merely a means to pay for a house; however it has shaped the property industry to such an extent that any changes to mortgages (interest rates, risk outlook or qualifying criteria) influence the entire property market as a whole.

I the same way: if ERP license models should change, they have the ability to radically change or revolutionise the ERP industry.

5.1.2 The economics of software

The research evaluated software in terms of the economics used for "brick and mortar" manufactured goods and found the economic theory to be lacking.

The two major points where software departs from the makeup and economic behaviour of other manufactured goods are that:

- Software has no intrinsic value (only instrumental value) and;
- Software has an effective marginal cost of zero

A famous historical event where the lack of intrinsic value caused a market collapse was the dot com bubble burst in the early 2000's. Whilst commodity markets may rise and fall, they will always be supported by the intrinsic value of the underlying good being traded. In the technology sector however, this was all based on populous sentiment. Once the outlook for technology companies turned bearish, their stocks crashed almost overnight.

In the same way, the enthusiasm for ERP companies are underpinned by their ability to generate massive and growing revenue from license revenue. If the license model should change drastically, it's likely to change the sentiment around ERP vendors as well.

The observation of "zero marginal cost" seems to be scarcely documented in literature, but carries equal if not higher importance than the first point. The reason for this is that reservation prices (absolute minimum sustainable prices) are protected (in a purely competitive market) by the intrinsic value and marginal cost of a good.

For software, a manufacturer could potentially manufacture a billion copies and sell them at 1c (and still turn a profit). This is an extreme example, but certainly points out the danger of ERP (or any other software) moving into a purely competitive market.

5.1.3 Importance/Justification for the research

The importance of the research was found to have impacts from all perspectives:

- Scientific Community
- ERP Vendors
- Implementation partners
- ERP Customers

It was found that each group represent their own specific importance/justification for the research, but in general: **this research is important since the economic mechanisms and effects of ERP license models are not well documented. The revenue and profitability of the entire ERP software industry is reliant on this.**

A multi-disciplinary approach (using Software Engineering, Complex Systems Theory, Microeconomics, Value Engineering, Statistics, Systems Engineering) would capture and analyse the mechanics and behaviour of ERP licenses in full.

5.1.4 Software License Models

The section on software license models started by exploring how software costing models work and discovered that these are nothing more than advanced project costing and feasibility tools. There is no hard scientific way to determine a profit maximisation point for software licenses.

The literature further exposed the “black magic” used in license modelling and price determination for software. It also exposed how powerful Price Discrimination could be for software which is further amplified by the existence of a zero marginal cost. The zero marginal cost implies that even the consumers with the lowest reservation prices can be accessed provided that this will not contaminate the rest of the (higher paying) market.

The license model review explored literature to unpack the various types of license models and see which type of license model is correlated with which category of software. It was discovered that enterprise and specialised software tend to lean toward the more complex license models, but that software in general tend to have simple “per-user” license models.

What was also interesting is that although the past has delivered very complex (performance based) license models (such as the MIPS license model from IBM), these have all simplified over time to become “per-installation” or “per-server” license models.

The three “license mortalities” were also explored (perpetual, subscription and usage based) and these were likened to different forms of accommodation (owning property, renting an apartment or staying in a hotel) to illustrate the advantages and trade-offs that each mortality provides.

5.1.5 ERP License Models

In terms of ERP license models, there was a clear difference identified between Tier-1 (SAP and Oracle) and Tier-2 (the rest of ERP vendors) license models.

Tier-1 license models are typified by complex, multi-metric, negotiable license models that have to be compiled and audited by an experienced professional. Tier-2 license models on the other hand are usually “per-user” (single metric), transparent license models with the pricing often published online.

Despite this difference in Tier-1 and Tier-2 license model, all ERP license models tend to be “perpetual” license models with an annual maintenance fee. This means (that in spite of the hype), very few enterprise software packages are available on subscription or usage based license models.

5.1.6 What is commoditisation and how does it work?

In the section dealing with the mechanics of commoditisation, it was explored how al markets start out as monopolies and how some of these markets move to being purely competitive.

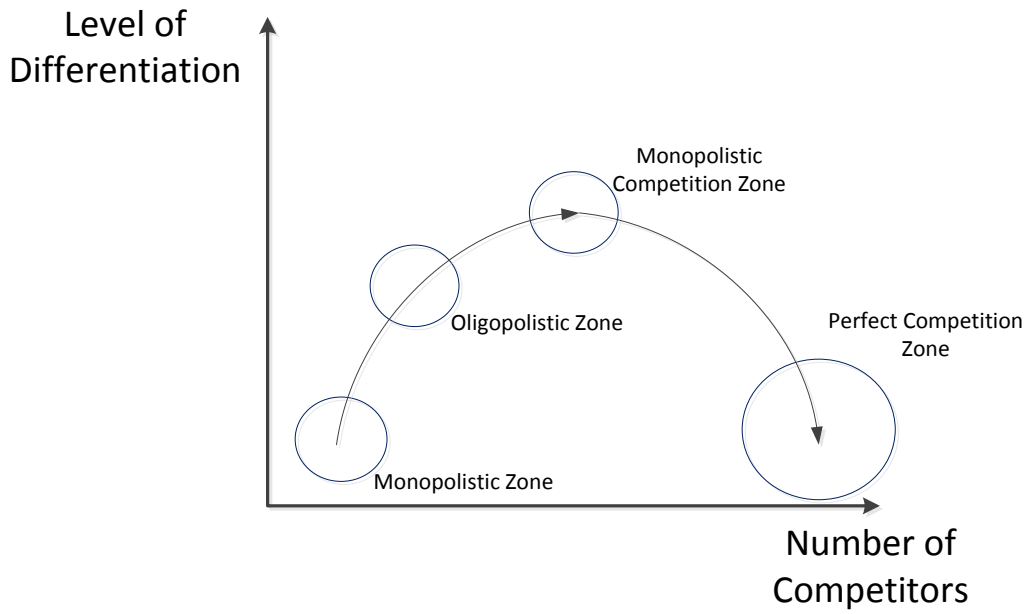

Figure 46: Journey from Monopoly to Perfect Competition

It was also discovered how Monopolistic Competitive markets typically present a higher level of differentiation that Oligopolistic markets.

Finally it was observed that the ERP market currently seems to exhibit characteristics of a monopolistic competitive market.

5.2 Framework for a sustainable ERP License model in an increasingly competitive software market

The aim of the research was to determine (by using a multi-faceted) approach what the future of ERP license models will look like.

By finding answers to a series of the following questions, one is able to determine an operating framework within which future ERP license models will form.

5.2.1 Are the value and cost linked in the current license model?

This seems to be true in a perfect world scenario (simulation); which is admittedly never the case.

In the software simulation, the overall result yielded an excellent correlation between ERP Cost and ERP Benefit (Saving). This condition held even under adverse market conditions.

The most interesting observation from the software simulation was found in the experimental simulation where the license model of the ERP was changed from a Tier-1 to a Tier-2 license model. Although this was the scenario that yielded the most stochastic output of all, the resulting correlation between ERP Cost and Saving was still statistically very high: 0.981. It was also interesting to note that the overall response (shape of the graphs) very closely mimicked those of the full Tier-1 ERP license model.

5.2.2 Is ERP likely to commoditise?

According to the literature and the author's interpretation of the various Economic market classifications (Monopoly, Oligopoly etc.) the ERP market is currently in a state of Monopolistic Competition (see section 2.4.1.2 Are modern ERP systems differentiated?).

The author also postulates that the competing ERP products are quickly becoming undifferentiated with all of the major ERP vendors converging on a common set of features, functions and delivery methods.

The only differentiation that seems to remain in the ERP market is between the vendors that use a simple (transparent) license model and those that have complex license models.

Commoditisation is not scientifically measureable and thus further could include a component of qualitative or quantitative research to measure the market sentiment about the level of commoditisation in the ERP market.

5.2.3 Is the current ERP license model sustainable?

From the literature (Konary et al., 2004) and from the qualitative field research, it seems clear that there is a drive towards subscription license models. Based on the current knowledge, this would favour the simpler license models over the complex license models. In this scenario, simple license models will be sold or leased as subscription licenses (based on users, rather than installations or master records).

An evolution that the simple license models may have to consider in this regard is a more detailed classification between different user types, thereby positioning usage/value metrics by the virtue of a users' capability or intention in using the ERP software. A "purchase manager" license could for example be made more expensive than a "stock controller" license.

5.3 Conclusion

The research has provided extremely interesting insight into the entire software licensing field as a whole.

In addition to identifying and exploring possible flaws in the economics used to model and analyse software, it has also provided great insight into the specifics of ERP license models and the forces that will shape the future of this market.

It was remarkable to see how well Tier-1 ERP licenses are linked to value. Unfortunately it wasn't within the scope of this research to understand whether this license model was deliberately complicated to align to value or whether it was done to complicate the "negotiated good" during the sales cycle.

It was also interesting to note that a simple "per-user" license (although having a weaker value linkage) exhibited the same behaviour (curve shapes) under varying market conditions in the software simulation.

What ERP licenses will look like in detail ten years from now is impossible to say. The fact that it will be subscription based and transparent is highly likely.

Whether the current Tier-1 vendors will still be known as the "big names" in the industry is uncertain.

The final conclusion is that Tier-1 ERP vendors will have to perform thorough introspection in order to decide what they will need to change in order to face this brave new reality, despite the fact that their license models were perfectly linked to the underlying value after all.

5.4 Future Research

Areas of research that have emerged from this research as promising (but were not in scope) are:

- The ultimate subscription license: Conceptual subscription license designs for ERP and their economic benefits
- Could the ERP market end up like the automotive industry: consolidated and nowhere to go
- Back to basics: Could the "smart supply chain" see the future of ERP being stripped of features rather than expanding on what there is today?

5.4.1 The ultimate subscription license: Conceptual subscription license designs for ERP and their economic benefits

The research has indicated that there is a big likelihood of future license models being based on subscription license models. It is important to remember that a subscription is a delivery method rather than a license model in itself, therefore these subscription license models still need to take shape in the form of a "user-subscription" or by some other metric.

There is currently no indication on what type of subscription license models the future of ERP will hold. Research into this field could yield interesting findings with regard to the popularity, feasibility and effect that various different subscription license models could have on the ERP ecosystem.

5.4.2 Could the ERP market end up like the automotive industry: consolidated and nowhere to go

Another interesting observation to emerge from the research is the fact that the automotive industry was also once a fiercely competitive landscape with hundreds of manufacturers in the USA alone. Today this market has consolidated itself so that only a few conglomerates remain.

Research into this field could try to establish economic, organisational, geographic and strategic links between the automotive and ERP industries which may yield some answers to the question of whether the ERP industry is likely to consolidate itself massively one day.

5.4.3 Back to basics: Could the "smart supply chain" see the future of ERP being stripped of features rather than expanding on what there is today?

There is a lot of hype around the "smart supply chain" that will see processes that are upstream and downstream of an organisation integrate directly with the ERP of the organisation and handle many functions that are dealt with by the companies' ERP.

Whilst the Supplier Relationship Management (SRM) and Customer Relationship Management (CRM) modules in the current ERP systems try to manage the processes and behaviour of customers and suppliers, in this "connected future" these modules will simply be an interface into the downstream and upstream processes.

Whilst this does not remove the requirement for ERP, it does potentially scale down the features and depth of functionality required in a typical ERP.

Research into this field could help to determine whether ERP systems will start to strip down functions and end up becoming (super-connected) accounting and payroll systems whence they came from initially.

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6 APPENDIX A - SOFTWARE LICENSE MODEL REVIEW

Software Licenses are the legal instruments (usually in the form of a contract) that allow and govern the way in which end-users may use software (Konary et al., 2004).

Interestingly, in most countries, a software license is not bound to the OEM installation disc that is distributed with a traditional software purchase (Cusumano, 2007). This means that the end-user that owns the license to use the software is free to make copies of the installation disc as long as he/she does not use or distribute the software in a means contrary to what is stipulated in the End User License Agreement (EULA).

In the EULA, it is specified exactly how and where the owner of the software license is able to install the software and how they are allowed to use it. Examples of these specifications may be the fact that the user may only have one active installation of the software. This means that the user is allowed to re-install the software (on the same computer or a different one) only if and when the original installation has been deleted.

Software Licenses for software aimed at the consumer market are usually very simple and clear and are primarily intended to prohibit the duplication, piracy and distribution of the software (Microsoft, 2013). These licenses are not concerned with how many members of the family use the software installed on the home-computer or whether the computer has a very powerful CPU that can run the software faster.

Enterprise software vendors on the other hand tend to come up with very creative and complex ways of licensing software. This ranges from the simpler “Volume License Agreements” through to hybrid-multi metric licensing models (SAP AG, 2012; Oracle corp., 2013).

These software license models may require the end-user to disclose many other facts of their business over and above how many people use the installed software. This may include knowing how powerful the CPU is of the computer where the software is installed or how many orders the software was used to process.

At first glance, it seems that these vendors are just trying to complicate and confuse the licensing process as to (arguably) extract more revenue from the end-user of the software.

On deeper inspection, it becomes clear however that these software models may have been developed with a very real and intricate purpose in mind, to charge the end-user proportionately to the value that they have gained from using the software, or at least try to.

This section will give an overview of the most common license models on offer at the moment as well as exploring how the different license models function as revenue generating vehicles for the software vendor.

6.1 A framework for categorising software licenses

When classifying and categorising software licenses, one needs to find the appropriate dimensions to classify the different types of software license models by.

This in itself is a mammoth task seeing that every second scholar finds a new way of classifying and categorising software license models (Cusumano, 2007).

Some of the typical dimensions that license models are disseminated by are (Bontis & Chung, 2000; Cusumano, 2007; Fishburn & Odlyzko, 1999; Lehmann & Buxmann, 2009):

- Perpetual (pay once off) or subscription (recurring payments)
- Usage dependent
- Installation Footprint dependent
- Hardware or resource dependent
- Cost-based or “customer-perceived” value-based
- Simple or Hybrid

The following section will therefor explore the software licenses currently in use along these typical dimensions of classification. In addition to this, the author would like to introduce a new dimension that deals with the notion of “Empirical Customer Value Link”.

6.2 Link between license model and empirical customer value

In the categorisation dimensions that are typically found in the literature, there is a concept or "perceived customer value" (Harmon et al., 2005). A different way to explain this is "what does the customer feel the software is worth". However, this use of customer-value is focussed on the "willingness to pay" principle (from 1st degree Price Discrimination). It does not mean that the software is actually brining that amount of money extra in or saving the customer that amount of money.

Whilst it is very important to understand willingness to pay, especially when maximising profits in a monopolistic competitive market, it still has no indication of whether the customer is actually realising benefit from the software (Harmon et al., 2005).

In the same way that pharmaceuticals in the UK (Latif, 2013), Germany and the USA are remunerated on the basis of monetary value added to the economy (in terms of life expectancy increases for patients), software needs to move towards a model where the license fee is determined by the monetary benefit that the software brings about.

It is not yet the aim to investigate how to exactly calculate the monetary benefit, however it needs to be determined at this stage whether a license model is

1. Not linked to value at all
2. Linked to perceived customer value
3. Linked to empirical customer value

The following table provides a breakdown of the major license models with this measure of value in mind.

Table 7: Breakdown of major License Models

Name	Description	Praise	Criticism	Typical Application
Per Named User	This refers to a specific set of users that are licensed. If two natural persons in an organisation hold these licenses they can operate the software simultaneously but no one else is allowed to do so	The licensed users are certain to have access at any time they need it	These licenses are prone to become part of the shelfware cost. Not all the users will use the software to the same level of benefit with some users never accessing the software. Some other users that would actually realise great benefit from the software sometimes do not receive a license	This is by far the most common mode of licensing enterprise software, where multiple users log on to the same system. This is also the most common licensing model for SaaS software delivered over the web.
Per Concurrent User	This refers to the amount of users using the software at any given time. If a company owns two Concurrent	This is more aligned to the actual usage of the software than the "Named User" model	This license model is often criticised for leading to critical users not having	This model is becoming more popular in the enterprise software realm. Many software

	User Licenses, then any two people are allowed to access the software simultaneously, but a third person is not allowed to do so. Should one of the two log off, then the third person may log on and use the software	since it can allow any two users to work simultaneously. The usage in this sense still does not guarantee the level of benefit that logged on users may receive from the software however.	access at peak times (say month end). This either makes users lose faith in the software or it makes the firm buy more licenses until this model eventually becomes more costly than the named user license model	packages such as Business Intelligence software now offer and option for either licensing named users or concurrent users. Concurrent user licenses are usually charged at a premium (1:3) over named users.
Per Server	This refers to the amount of servers that the software is installed on. If a company owns two of these licenses, then they are allowed two (production) servers with this software. Test and Backup servers are usually excluded from the count of licensed servers.	This model is very clear and simple to administrate. There are no difficulties in managing individual user counts with the vendor.	This model has come under criticism for charging the same whether it is installed on a small desktop server or a massive rack mount server. Also, with the migration	This model works well for specialised back-end systems such as plant automation software.

	Also, there may actually be more than one instance (installation) of the software running on a server.		towards virtual servers, vendors argue that each virtual server constitutes a sever and customers generally disagree.	
Per CPU/ RAM Size	This license model is priced based on the amount of CPU's or the size of the RAM in the server that it runs on	This model is closely linked to the dominant license model from the mainframe era that used the amount of MIPS (Million Instructions per Second) to determine the license fee. To some extent this license model is linked to utility especially for processing intensive software	This model would be subject to the same criticism that the MIPS license models of old endured, in that the same amount of processing would require more resources on (an equivalent but) less efficient hardware setup In addition to this, when	Despite the controversy and unpopularity of the model amongst customers, this is the most common non-user type license in use today. This license model is used for a wide range of software from Database software right through to Business Intelligence software.

		applications.	multi-core processors started to emerge, this sparked disagreement between customers and vendors whether a second core counts as a separate CPU	
Per Installation	This refers to the amount of active installations of software. This is by far the most common license for consumer software such as MS Word. The license agreement stipulates that the owner is allowed to run one installation of the software. Thus only when he/she removes it from their old pc are they allowed to	This license model is also very unambiguous in nature and is (byte for byte) probably still the most common license model in use today.	The main criticism of this license model is that there is no link between the license fee and the level of benefit that the end-user experiences from using the software.	This license model is most commonly found in consumer software such as MS Word, but is also common in non-system enterprise software such as CAD/CAM packages.

	install it on their new pc.			
Per Site	This license model implies that an entire site (but only that site) is licensed for the specific software. This usually includes unlimited installations and users (as long as they are stationed at that site).	The advantage of this license model is that the purchaser may use the software to its fullest potential without worry of additional license fees for a site. If a system has any chance of proliferating, it usually does so well with the per-site license model since there is no constraints as to by whom (or when) the system can be accessed.	The main criticism of this license model type is the ambiguity in the definition of a site. Usually the customer would try to cluster sites as one whereas the vendor would try to sub-divide a site into many. A problem that vendors may experience is in ensuring only users stationed at the site use the software.	This type of software license model is typically found in specialised manufacturing and logistic software such as warehouse management, asset management or access control software.
Employee Count	As opposed to licensing a site, this license model takes count of the amount of employees (users and non-	If the software provides equal benefits to all employees in an organisation (e.g. payslip	The main criticism is that the benefit delivered is not linearly related to the	This type of software license is mostly implemented for EH&S compliance software as well as

	users) in a company or at a site. The license is priced based on the amount of employees that fit the description (e.g. employees at site a, or production employees in the entire company)	calculation) or provides linear benefit to the organisation for each additional employee (Safety, Health and Environmental compliance) then this license model is perfectly aligned to the delivered value.	amount of employees (i.e. managing the EH&S for 10 employees is not 10 times as cumbersome as for 1 employee).	specialised software for Professional services companies. Employee Self Service (ESS) software such as leave and payslip management, the employees are usually seen as named users to the system.
Data Size	This license model refers to the size (usually in GB) that the data in the system is occupying. The license fee is usually charged at an annual database growth	This license model is definitely linked to utility (customer benefit) regardless of how strong or weak this link is. If the customer doesn't ever use the system, the data will remain static and there will thus be no cost incurred.	The main criticism is that the growth in data is highly dependent on how the system is configured. I.E. if company A only updates 3 fields per order and company B updates 10, the latter is sure to pay more per sales order.	This license model usually forms part of a hybrid licensing strategy. The Data Size license usually pertains to the back end database server.

			The counter argument may be that company B is getting more utility by updating 10 fields and thus should pay more.	
Records or Data Objects handled	This is similar to the "Data Size" license model but differs in that it views a record as a collection of data (data object), irrespective of size.	This license model is also irrefutably linked to actual customer value realised. The fact that the license model disregards the size of a record alleviates the problem illustrated in the previous example where company A and company B pay different amounts for processing a sales order.	The one criticism that this license model is prone to is the fact that (expensive and inexpensive) assets and (large and small) sales orders cost the same to process.	This type of license model is also typically part of a hybrid licensing scheme. As illustrated in the examples, this licensing model usually applies for Master Data or Asset Management applications.

Per Manufacturing Resources or Assets	As the name indicates, this license model is usually costed based on the amount of resources (machines) are managed by the software	The main advantage of this license model is that it will be cost effective for small manufacturing operations. As they scale up their manufacturing operation, the license cost will increase.	The main criticism of this license model is that it doesn't take the size or capacity into consideration. A small manufacturer with 10 mini presses may end up paying more than the large manufacturer with two mega presses	As eluded to, this type of license model is almost exclusively used for manufacturing operations. A variant of license model is popular where server or data centre management software is deployed.
Transaction Volume	This type of license measures the amount of transactions (however they are defined) to determine the amount of license fee payable.	When used to measure sensible transactions such as "sales order processed", the license model is genuinely linked to customer value. The problem is however, that it usually does not distinguish between the type of	The main criticism that this type of license model receives is the fact that it can introduce unpredictable license cost into an organisation. If the transaction definition is counted as people visiting	This license model is applied widely in the enterprise software market for everything from completed e-learning courses and posted sales orders through to Electronic documents sent between business partner firms.

		transactions or the size of the sales order	the online store, close to Christmas, the company may get many visitors without anyone buying anything. This could introduce a surprise surge in license fees without the Revenue going up.	
Production Volumes	A Production Volume License model is tailored to the specific industry (type of mining or manufacturing) that it services. The license cost will be determined by the amount (e.g. ounces of silver) that the company produces or converts.	This license model has found very limited use to date. If the software is truly responsible for improving production in some way, this is the most tightly value-linked software model. The firm will pay exactly proportionally to the benefit	Where this type of license is applied, the software is so specialised that there usually is no substitute software with a different license model to choose from. In the literature (Konary et al. ,2004), this license	This software is usually employed in manufacturing modules of an ERP or specialised production enablement software.

		received from the software.	model proved to be very unpopular.	
Revenue	This type of license model is similar to the "Production Volumes" license model, but measures Revenue of a company (or business unit) enabled by the software in question to calculate the license fee payable. In the case of public sector organisations, Budget is used in the place of Revenue since this would be the equivalent of Revenue for a non-profit organisation.	Again, when the software truly contributes directly to the customer's capacity to generate revenue, this is a intimately linked to business value as it comes.	Only when the software applies to an extremely focussed (revenue generating) business process (such as debt collection) or across the entire company can this model be relevant. If this model is for example used for an email server, the amount of email is in fact likely to be inversely related to the amount of (spam) email that employees send.	This type of license model has found slightly more use than the Production Volume license model. Being one of the only truly value-linked license models, it has not nearly found as much use as one would have guessed. In the literature (Konary et al.,2004), this was also one of the least favourite license models amongst customers
Business Partners	This license model is arguably a variant of the "Data Objects" license	In Business to Business dealings, many things are	A key criticism of this license model is that it does	This is typically part of a hybrid license model employed

handled	model since it charges according to Data Objects or "Parties dealt with"	decided, scoped and dealt with based on how many business partners are involved. In this sense, this license model is not unusual for software that manages suppliers, customers and service providers.	not consider the interaction with each business partner. If a company has many inactive (dormant) business partners on a system they will pay for non-value adding activities.	in Business 2 Business software such as ecommerce, Customer Relationship Management and Supplier Relationship Management Software.
Amount of Spend	This license model is also related to the Revenue and Production Volume Licenses but focuses on Spend instead of revenue. This is applicable to areas where the only immediate measurable is spend such as Project Management or	In situations where software improves the outcome of a capital expense such as a plant expansion, it seems fair to relate the benefit realised to the amount of spend. In this sense, the focus is on the benefit realised during the	The irony is that if the software cannot support the project sufficiently and there are budget overruns due to this, the licenses will end up costing more (for a reduced benefit).	As mentioned, this type of license model usually applies where Capital Expenditure is involved such as Project Management.

	Subcontractor Management.	capital expenditure as opposed to “because of the capital expenditure”		
Procurement Volume	This license model is analogous to the Spend license model since it deals with money spent rather than money earned. The unit of measure for this license model usually aligns to the volume and product (e.g. tons of maize) rather than a monetary value.	Like with the Revenue License Model, this license model is tightly linked to the empirical value add (provided the software actually adds value). In addition to this, it measures the amount of raw material procured but hedges the customer against passing on revenue from improved cost efficiency to the software vendor.	The main criticism of this license model is that whilst it hedges the customer in passing on savings to the software vendor, it exposes the customer to a drop in finished goods prices. This is certainly fair, since the customer still procured and processed x tonnes of raw material, however it is not advantageous for the customer.	This license model is typical to procurement software used in commodities trading such as agricultural commodities or mineral resources. It can also be found where manufacturers focus on converting a raw material commodities (such as grain) into bulk finished goods such as cake flour.

Asset Value	This license model is focused on asset value of assets such as: - Asset intensive industry, heavy machinery and Plant Equipment - Real Estate owned and managed by the customer firm - Financial Assets under management and hedge volume This is then in reality three types of license models measuring the same metric. The license fee is determined on the Assets under Management or the	As with the other empirical value linked models, if the software truly generates benefit in the process of managing assets, then again this model aligns exactly with value-add. This type of license model makes it possible for a small asset manager to start using enterprise grade software when starting up his portfolio. This holds advantage for the vendor once the small asset	Although the software aligns to the size of the assets under management, it holds no consideration for the performance of those assets. Thus, if a fund holds a large portfolio of non-performing assets in a bear-run, they will continue to incur high license fees whilst waiting for the market to turn. Since almost everything in the investment world is	As mentioned, this license model pertains to three main applications: - Asset (Machinery) management - Financial Asset Management - Real Estate Asset Management

	depreciation adjusted value or assets	manager holds a massive portfolio.	performance based (e.g. banker bonuses) this license model does not align to the industry behaviour.

7 APPENDIX B – SIMULATION RESULT DISCUSSION

This appendix details the discussion of the variables and purposes for each of the software simulation scenarios. For comprehensive charts that show all the results (not just the ones discussed here), please see the next appendix.

7.1 Results

7.1.1 Scnenario1: Raw material cost below sales price

7.1.1.1 Variable Explanation

In the model, the sales price of the finished good (bread) was determined by the Consumer Price Index (CPI) inflation.

The model assumes the cost of the raw material (flour, yeast etc.) to also follow CPI inflation and thus, the raw material cost will be fixed at a certain percentage below the sales price.

The input variable ("raw material cost below sales price") refers to this percentage gap between the raw material cost and the sales price of the finished good.

In the following equation:

$$\boldsymbol{Profit = Sales\ Price - (Raw\ Material\ Cost + Cost\ of\ Manufacture)} \qquad \textbf{Eq. 7-1}$$

The variable refers to the (percentage) difference between the "sales price" and the "raw material cost".

What this scenario then aims to test is how the license cost of ERP compares to the delivered value under varying levels of profit margin.

The input variable is represented as a fraction (percentage). This means that a value of 0.5 would imply that the raw material cost is 50% below the sales price. A value of 0.9 would mean that the raw material cost is 90% less than the sales price of bread.

7.1.1.2 Input Range and Step

Table 8: Scenario Input Range and Step

Range	0.05 to 0.9
Increment	0.03

The variable was adjusted in increments of 0.03 (3%) from 0.05 (5%) to 0.9 (90%).

In other words this compares the extremes where raw material costs only 5% less than the sales price through to the point where raw material costs 90% less than the sales price

7.1.1.3 Discussion

The ERP Saving has a flat response across the input range of the variable. In other words, as the input costs decreases (growing the profit margin) the ERP cost increases, however the ERP saving stays flat across the input range of the variable.

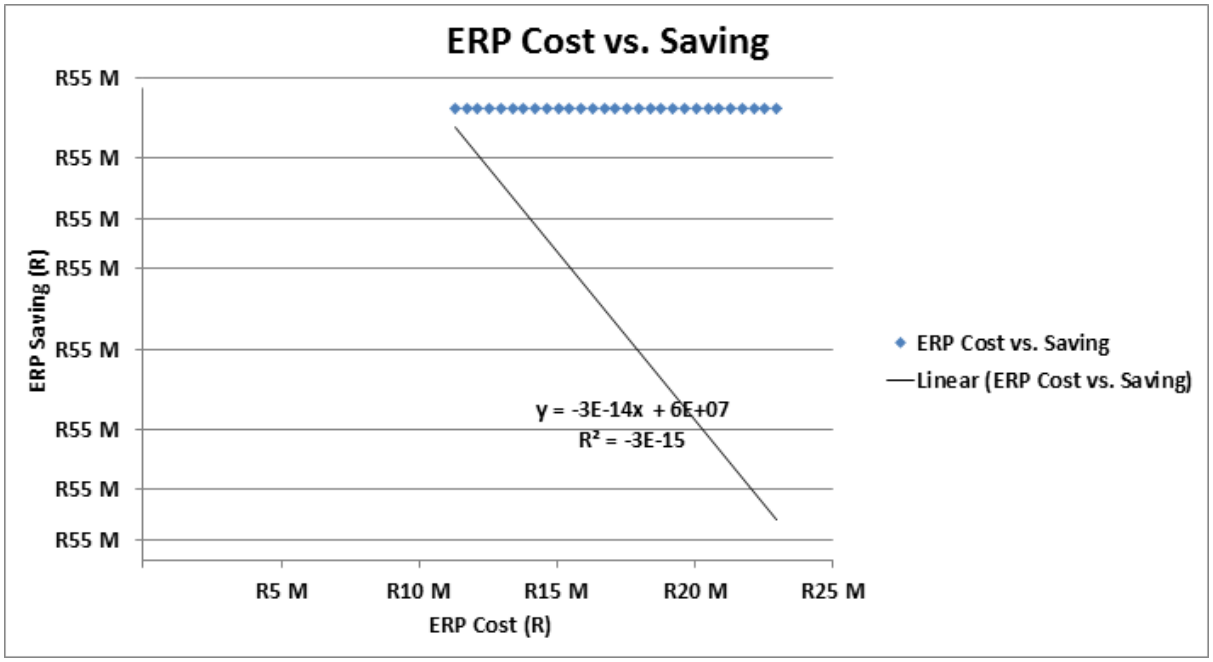

Figure 47: ERP Cost vs. Saving

Although the ERP Cost is strongly correlated to the ERP Saving throughout the range of the input variable, this correlation starts to drop (exponentially) as the input cost approaches zero. This indicates that higher margins will actually make the ERP to be less correlated to ERP savings.

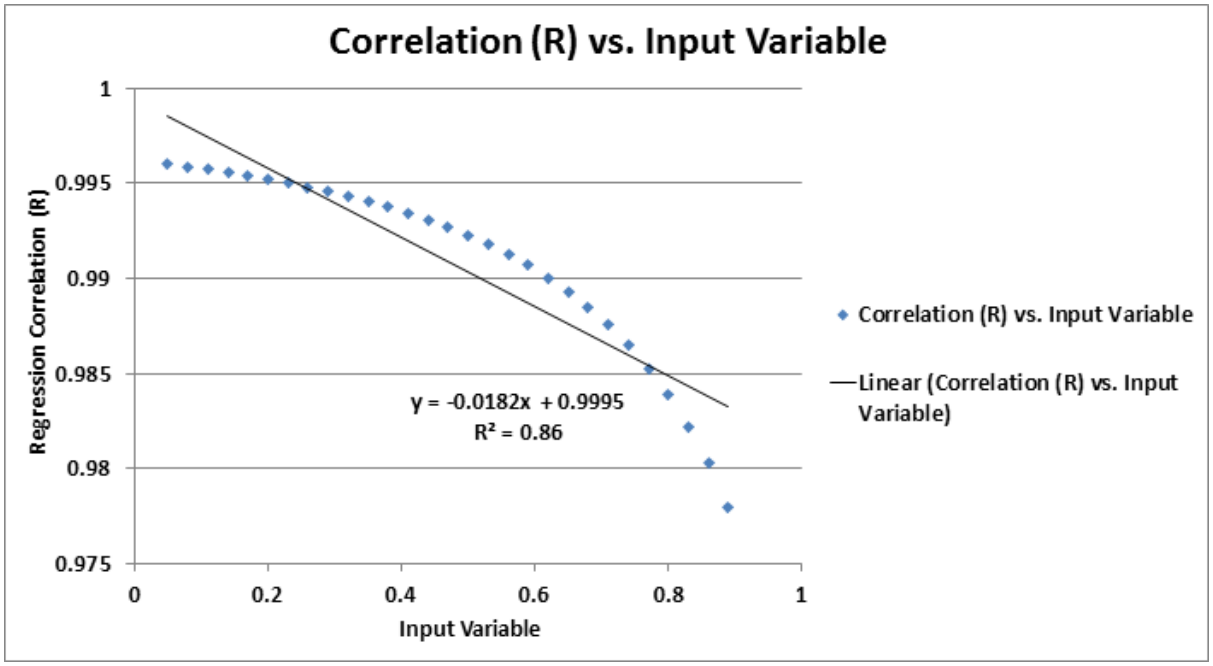

Figure 48: Correlation (R) vs. Input Variable

Another interesting point to note is that throughout the range of the input variable, the ERP seems like a sound investment with an IRR of greater than 20%. This is despite the fact that the firm is loss-making for the first two steps of the variable and only starts to make a decent profit a third of the way through the range.

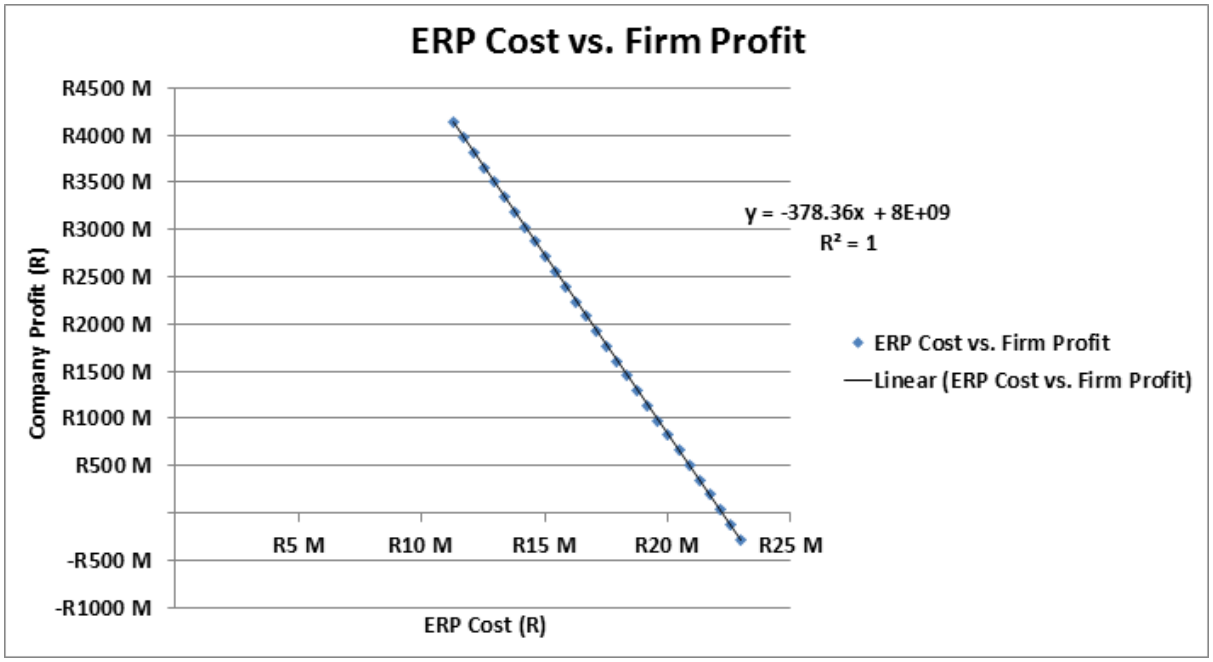

Figure 49: ERP Cost vs. Firm Profit

7.1.2 Scnenario2: Order Size

7.1.2.1 Variable Explanation

The "order size" variable is a multiplier that has been built into the base model and is used to multiply the "base order size".

As mentioned, the input data for daily order size is based on historical data that was multiplied to get to an acceptable daily order size for a typical bakery.

In this scenario, the adjustment of this multiplier-variable aims to simulate a depressed or elevated market where the order size would either be smaller or larger, yet at the same cost (ERP and other input costs).

This scenario should illustrate how well the ERP value is linked to license cost for different levels of depression in a market.

7.1.2.2 Input Range and Step

Table 9: Scenario Input Range and Step Size

Range	10 to 400
Increment	20

The baseline level for this variable was 100.

In the scenario, the variable was varied from 10 to 400. In other words, the starting point simulates a tenth of the order sizes in the baseline model. The final step simulates four times as many orders as the input data would generate for the baseline model.

7.1.2.3 Discussion

The most interesting point about this scenario has nothing to do with ERP licenses, but rather has everything to do with the validity of the model as a representation of an actual economic firm. Exactly as is depicted in every "Economics 101" textbook, the model illustrates the profit maximisation principle with economies and diseconomies of scale.

As can be seen on the chart below, for the first few steps of the increasing order sizes the firm's profit increases steeply (economies of scale) before slowing down. After the maximum profit point, the profit starts to decline rapidly with further increasing orders until it plunges below zero.

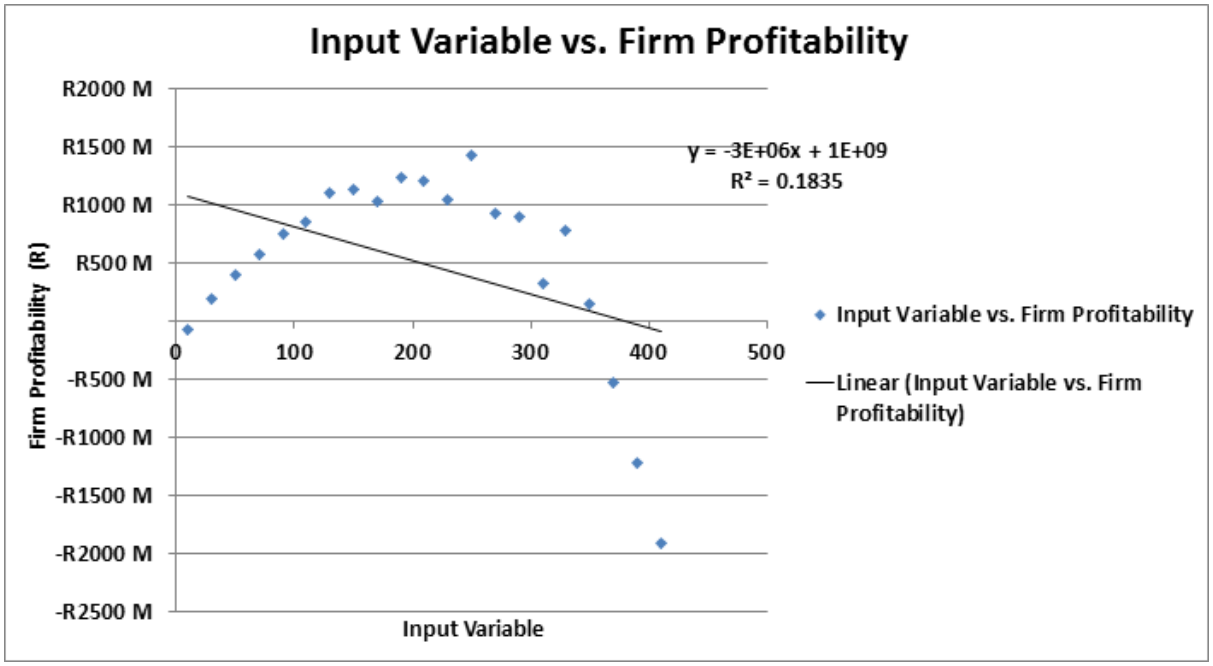

Figure 50: Input Variable vs. Firm Profitability

7.1.3 Scnenario3: Base Price

7.1.3.1 Variable Explanation

The "Base Price" refers the initial sales price of bread in 2001 after which it gets adjusted upward in the model (by CPI annually).

In this scenario, the initial base price is adjusted from a point below the baseline-point to a point above the baseline-point in order to test the response of ERP license cost vs. Value.

Since the bread price in South Africa is a regulated price (by government), this simulation tests the scenario where the bread price is unregulated or where the regulated price was set at lower/higher point. This scenario does not simulate varying levels of inflation.

The baseline point for this variable was R5.29

7.1.3.2 Input Range and Step

Table 10: Scenario Input Range and Step Size

Range	1 to 10
Increment	0.3

In other words, the scenario steps through initial prices from R1 to R10 in increments of R0.3 or 30 cents.

7.1.3.3 Discussion

The "base price of bread" scenario yielded very interesting results in that almost all the responses tested against the input variable produced a completely linear response.

The correlation between ERP Cost and ERP Saving remained very high across the range of the input variable with the correlation actually increasing as the bread price increased.

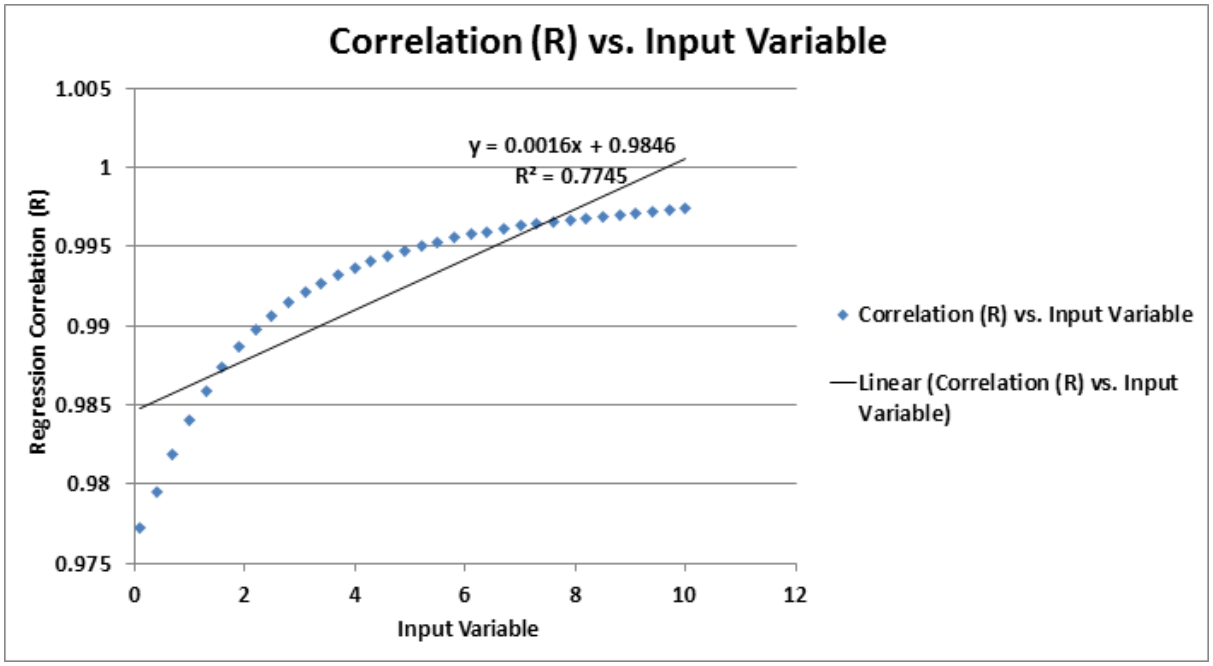

Figure 51: Correlation (R) vs. Input Variable

7.1.4 Scnenario4: Outsource Baking Cost

7.1.4.1 Variable Explanation

The Outsource Baking Cost represents the cost of outsourcing overflow capacity to another contract bakery expressed in "Rand per loaf".

As explained, the bakery in question is responsible to fulfil a production order whether it is able to bake all the bread itself or whether it then has to outsource some baking.

The cost of outsourcing a loaf of bread would obviously be at a point between the production cost per loaf and the sales price per loaf. In other words, it would be more expensive than baking the loaf, but less expensive than buying one from a shop.

This simulation tests the scenario where company may experience ballooning costs from its business partners and what effect this has on the value linkage of ERP.

The baseline variable for this outsource cost was set at R5

7.1.4.2 Input Range and Step

Table 11: Scenario Input Range and Step Size

Range	1 to 20
Increment	1

This range implies that the cost of outsource baking is varied from R1 (which is much cheaper than the cost at which the bakery can produce bread) to R20 (which is much more expensive than the price at which the bread is sold).

7.1.4.3 Discussion

This scenario yielded interesting results that speak to the artificial intelligence that has been built into the baseline model.

At very low values of the input variable, it is cheaper for the bakery to utilise outsource baking than to produce the bread itself. This causes the model to alternate between the decision to insource/outsource some part of the production order. The result yields certain step discontinuities in the responses of the some of the output variables.

Throughout the range of the input variable, there is very little effect on the IRR and no measurable effect on the ROI.

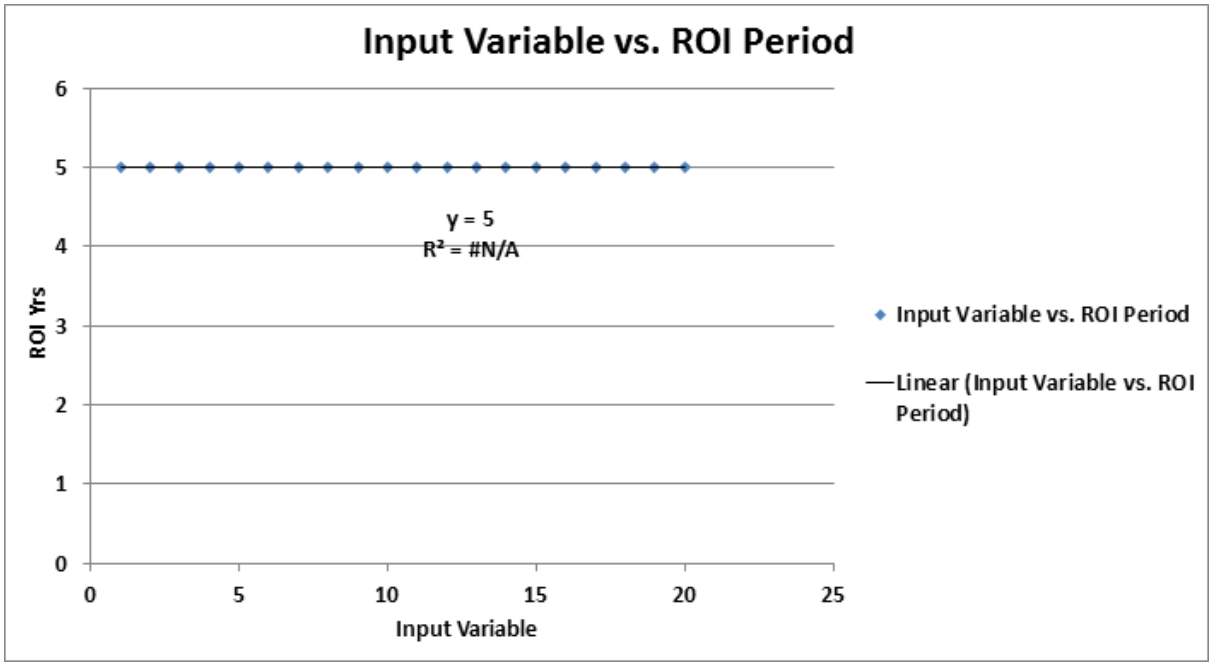

Figure 52: Input Variable vs. ROI Period

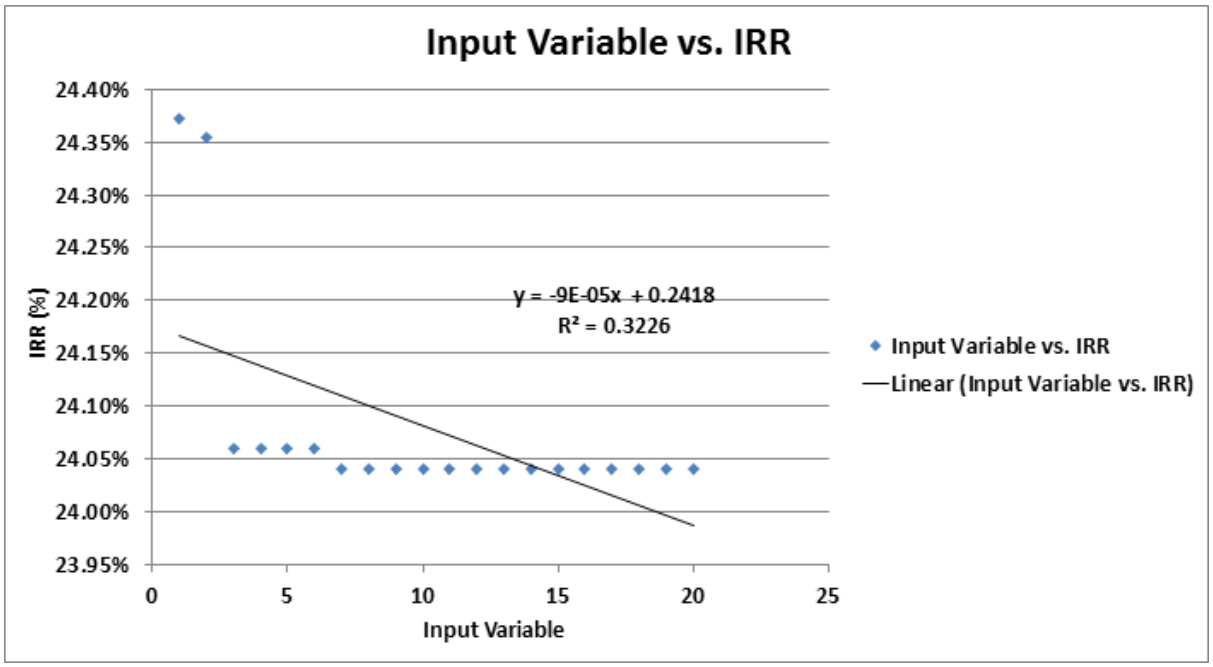

Figure 53: Input Variable vs. IRR

The correlation between ERP Cost and ERP saving is very high with little change in response to the actual input variable.

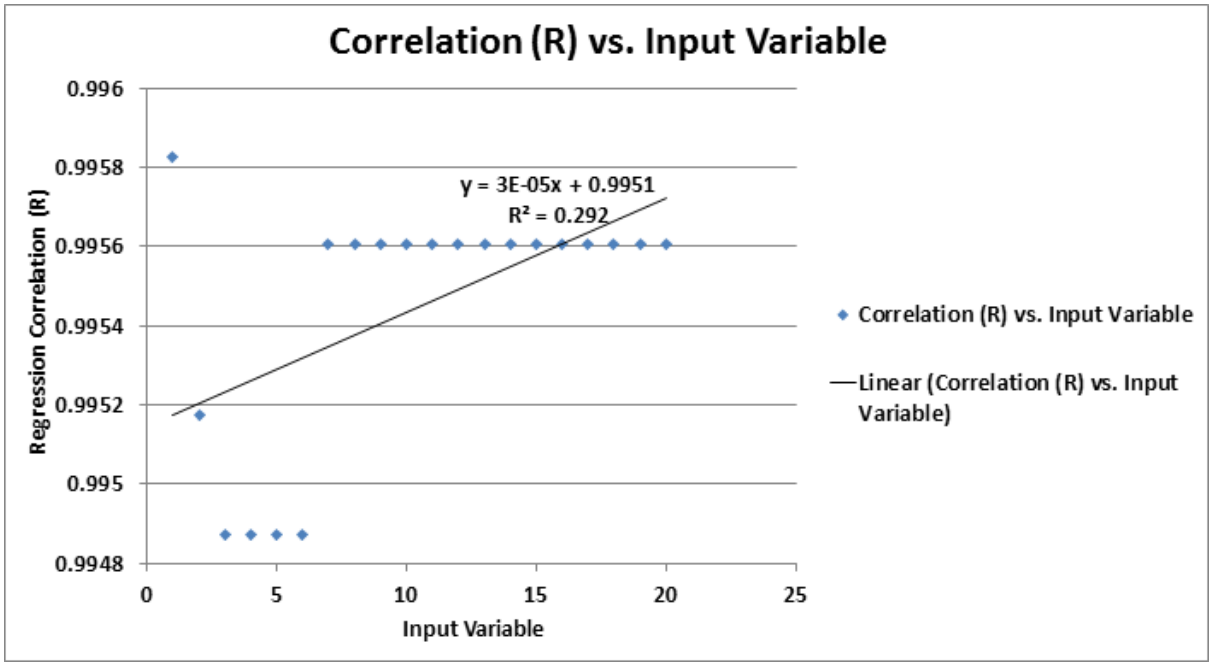

Figure 54: Correlation (R) vs. Input Variable

At each one of the discontinuities on the chart, the model made a new decision about using outsource baking or installing additional capacity. However, once the model has settled on a new level, it generally stays on that level for various consecutive steps of the input variable.

7.1.5 Scnenario5: Base License Cost of ERP

7.1.5.1 Variable Explanation

The "Base License" of ERP is the baseline license that a business has to acquire in order to make any use of an ERP. Only once the base license has been purchased, can other (user and spend volume) licenses be purchased on top of this.

This scenario tests the response between the base license cost and the ERP value.

The actual variable that was used by the simulation to step through is a multiplier of the base license cost. This means that in the baseline model, this variable is set to 1.

7.1.5.2 Input Range and Step

Table 12: Scenario Input Range and Step Size

Range	0.1 to 10

Increment	0.3

The variable was stepped from 0.1 (a tenth of the actual base license cost), through to 10 (ten times the base license cost).

7.1.5.3 Discussion

This is the first of the scenarios that is focussed on adjusting components within the ERP license model itself as opposed to the market conditions that the firm finds itself in.

As expected, the ERP Saving would have a completely flat response to changing the ERP Base License cost. In other words, the various levels of the input variable only causes the ERP license to become more expensive without adding any additional value (savings).

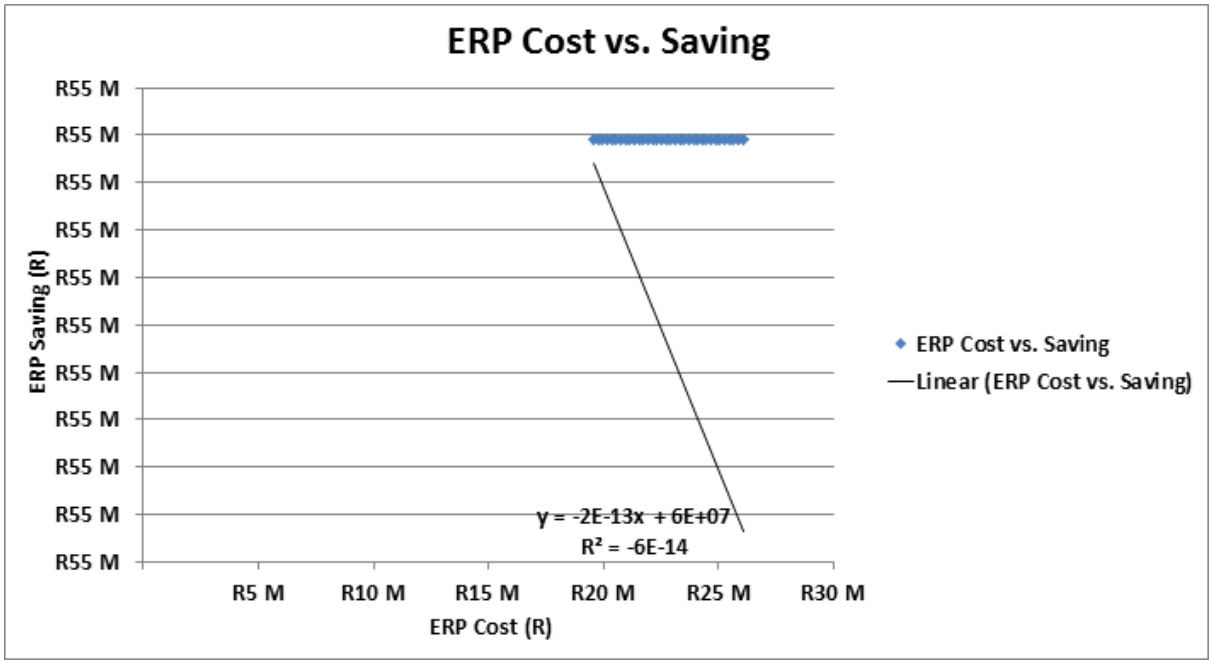

Figure 55: ERP Cost vs. Saving

An interesting point to note was that although the base license cost of the ERP was increased tenfold across the range stepped through in the scenario, the overall cost of the ERP (expressed as a percentage of the firm profit) only increased 1% from 2.5% to 3.5% (which remains low overall).

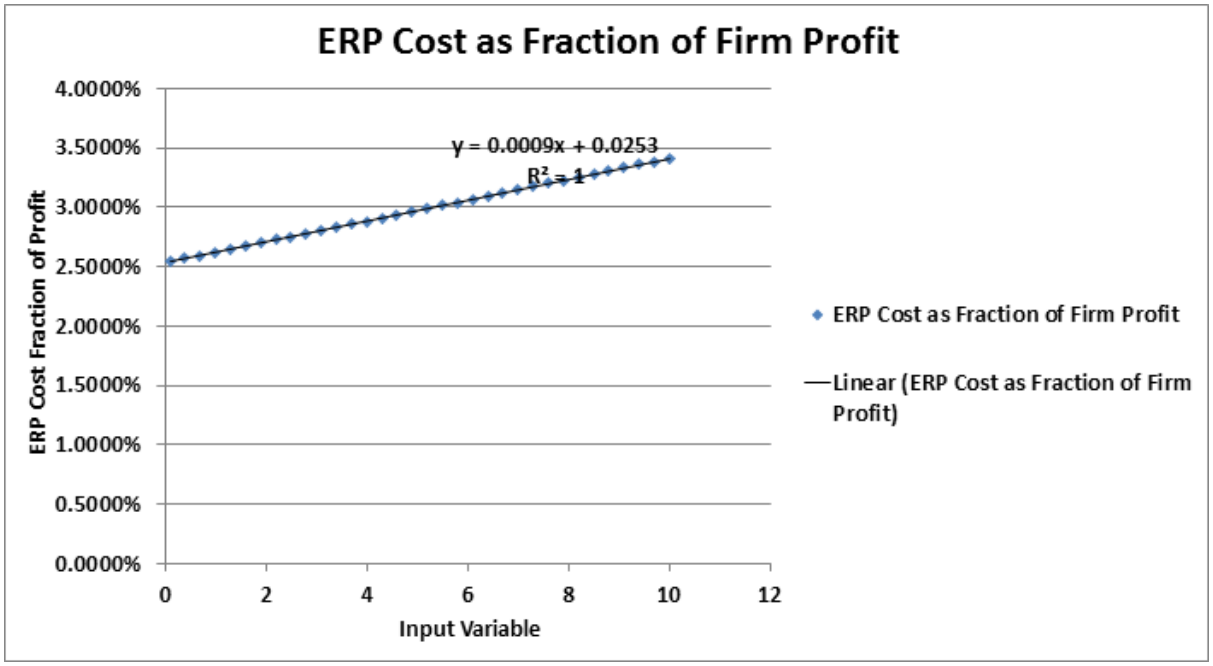

Figure 56: ERP Cost as Fraction of Firm Profit

In contrast however, the IRR of the ERP project decreases significantly from 25% to almost 10% across the range of inputs, making it a very unattractive investment.

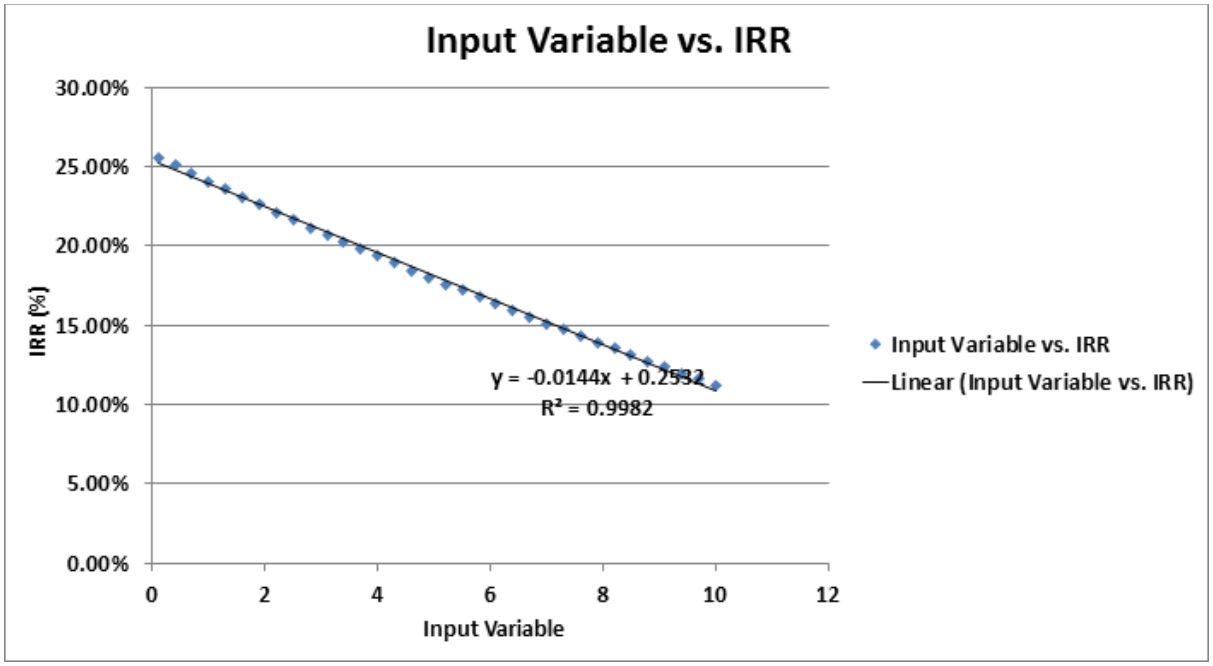

Figure 57: Input Variable vs. IRR

7.1.6 Scnenario6: ERP Volume Spend License Fee

7.1.6.1 Variable Explanation

The "Volume Spend License Fee" refers to the license fee that is charged based on the amount of transactional volumes (amount of money) that the ERP customer channels through the ERP system (purchase orders and sales).

This component of the ERP cost will thus (theoretically) be zero if a company does not gain any value from using the ERP system.

This scenario tests the response between the Volume Spend part of the license fee and the ERP saving.

The actual variable that was used in the simulation is a multiplier of the spend volume license fee. This means that in the baseline model, this was set to 1.

7.1.6.2 Input Range and Step

Table 13: Scenario Input Range and Step Size

Range	0.1 to 10
Increment	0.3

The variable was stepped from 0.1 to 10 in increments of 0.3.

This means that the initial step is a tenth of the actual spend volume cost and the final step is ten times as much as the actual volume spend.

7.1.6.3 Discussion

Again in this scenario ("Spend Volume"), as with the other "license-focussed" scenarios; changing a component of the overall license model yields a completely flat response in the ERP Saving.

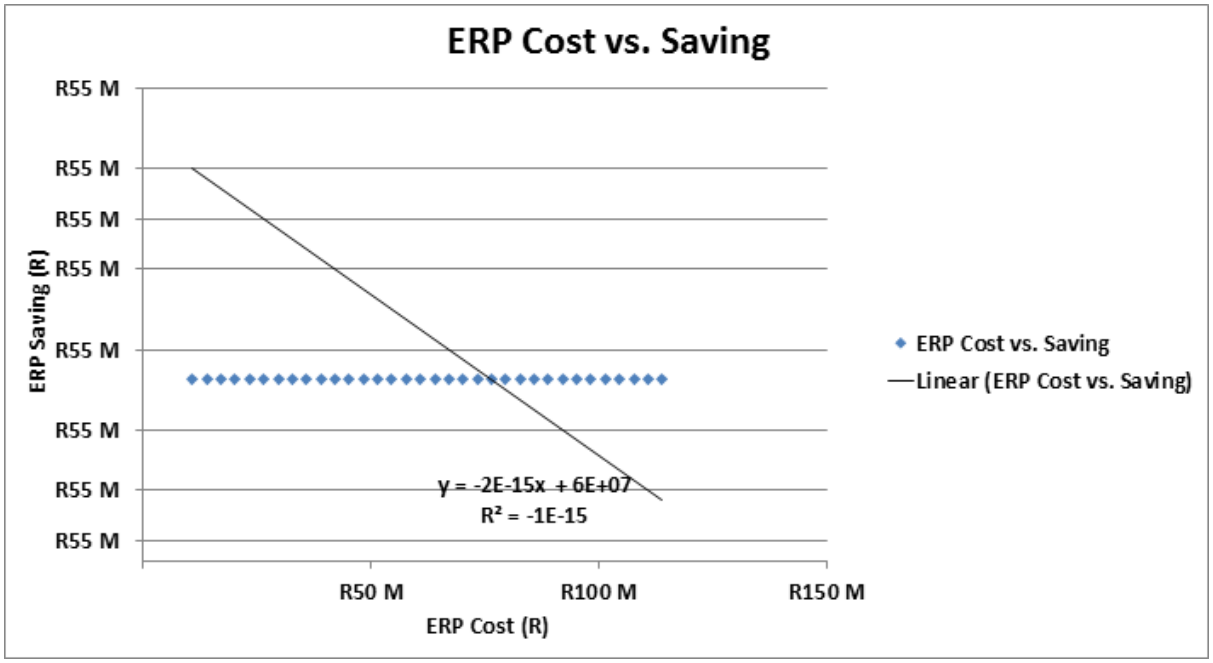

Figure 58: ERP Cost vs. Saving

This scenario is however the first scenario that sees the ERP Net Effect dip below zero. In other words, the ERP Saving decreases so much that the overall ERP cost becomes larger than the ERP Saving.

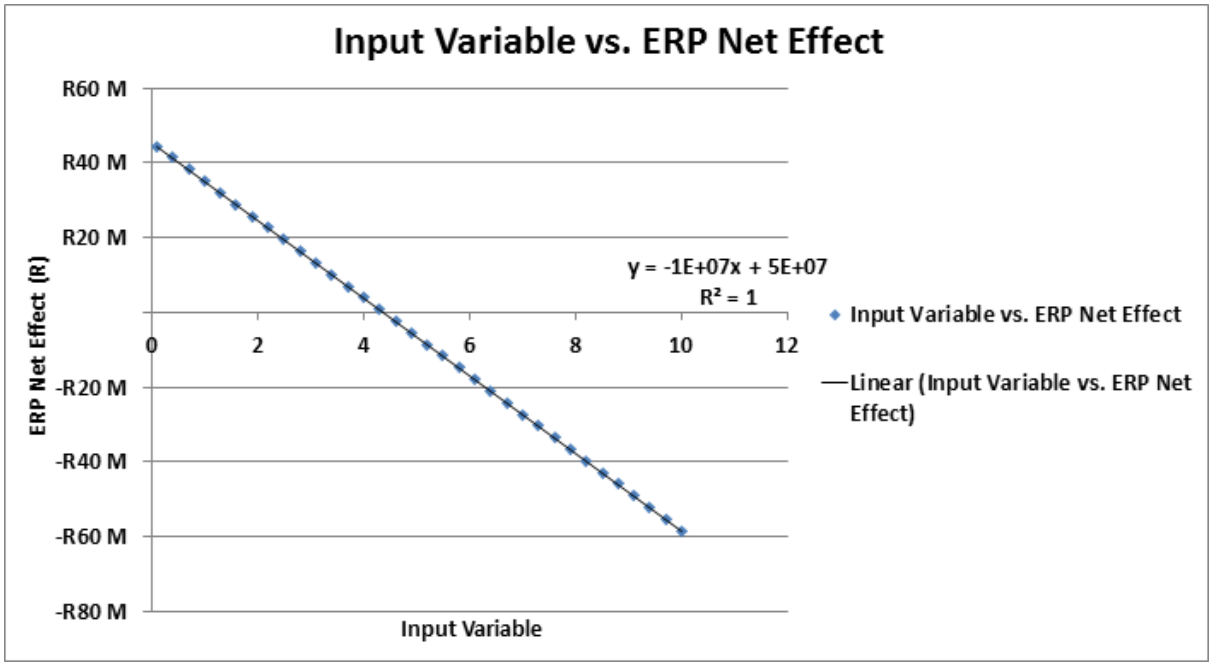

Figure 59: Input Variable vs. ERP Net Effect

Despite the drop in ERP Saving, the correlation between ERP Cost and ERP Saving actually increases over the range of the input variable towards a correlation of 1.

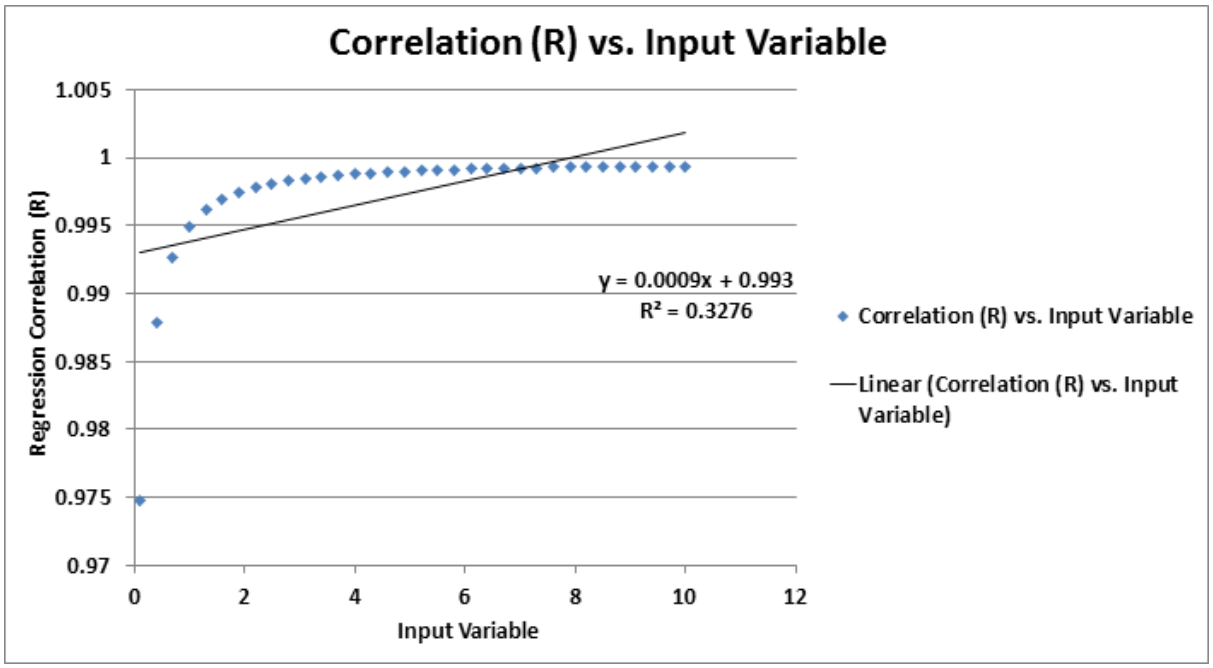

Figure 60: Correlation (R) vs. Input Variable

This is intuitive since the increase in the variable component of the license drowns out the fixed cost (base license).

7.1.7 Scnenario7: Maintenance Cost

7.1.7.1 Variable Explanation

In the baseline model, the cost of maintenance is a function of the installed capacity and what was actually produced using that installed capacity. This means that the maintenance cost would be non-zero even at very low production volumes, but will go up with increased production.

This scenario tests the ERP value response to varying maintenance cost.

The variable used models maintenance cost as a percentage of machine cost.

The baseline variable was set at 0.05

7.1.7.2 Input Range and Step

Table 14: Scenario Input Range and Step Size

Range	0.001 to 0.1
Increment	0.002

The input variable is stepped from 0.001 (0.1%) to 0.1 (10%) in increments of .002 (0.2%). In other words, this is modelling a range of maintenance costs from 0.1% of the machine cost to 10% of the machine cost.

7.1.7.3 Discussion

The reduction in maintenance cost ("Maintenance Saving") that is realised through the use of the ERP can be seen as one of the "free" benefits associated with the ERP. This implies is that the actual level of saving realised does not affect the overall cost of the ERP. To this extent, the input variable yields a flat (or in this case a vertical) response to the input variable.

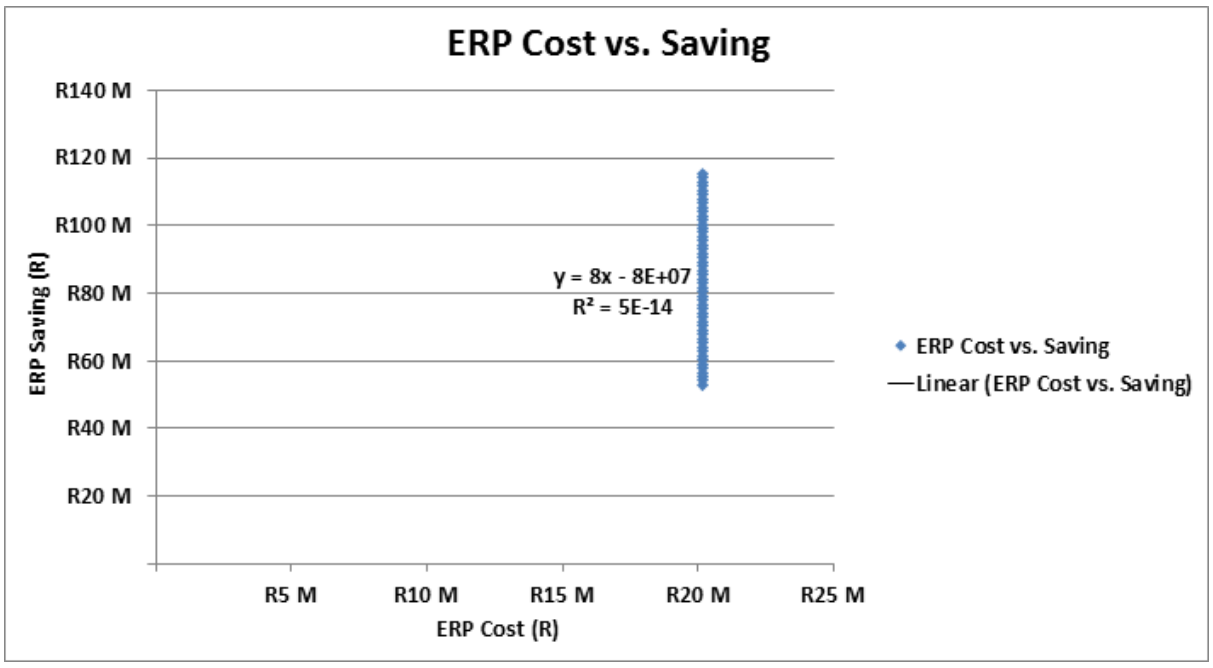

Figure 61: ERP Cost vs. Saving

The rest of the measured output variables yield a predictable (linear) response to the input variable.

Although the correlation between ERP Cost and ERP Saving remains highly correlated across the range of the input variable, there is a definite increase in this correlation as the maintenance cost increases.

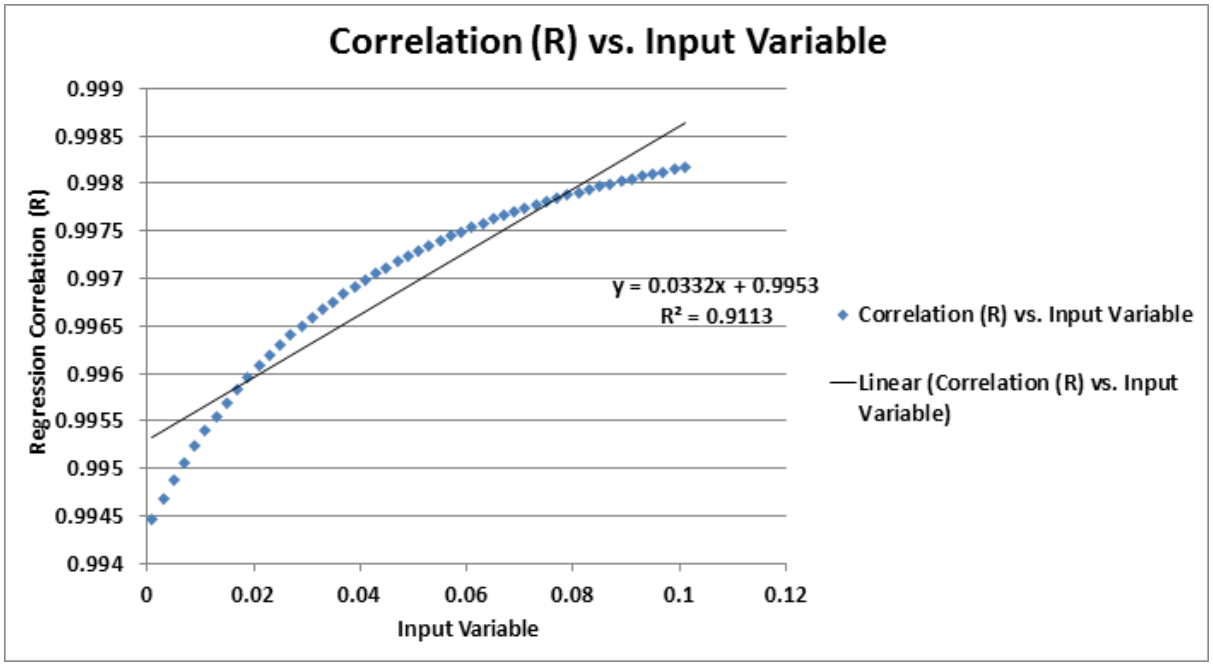

Figure 62: Correlation (R) vs. Input Variable

7.1.8 Scenario 8: User License Cost

7.1.8.1 Variable Explanation

The User License Cost is the license component concerned with the amount of users using the ERP system.

In the software model, the staffing was based on a pre-set ratio relating to the installed capacity for baking. This means (for example) that the bakery will hire 4 new production workers and 2 new admin staff for every 80 000 units of installed capacity. The growth of the installed capacity for baking in turn is determined (in general) by annually growing order sizes.

This scenario simulates the scenario of decreased or increased User License fees.

The variable used to step through in this scenario is a multiplier of the actual User License fees. This implies that this value has been set to 1 in the baseline model.

7.1.8.2 Input Range and Step

Table 15: Scenario Input Range and Step Size

Range	0.1 to 10

Increment	0.3

The variable was stepped from 0.1 (a tenth of the actual user license fees) to 10 (ten times the actual user license fee) in increments of 0.3.

7.1.8.3 Discussion

The "User License Cost" scenarios (as with the other license cost scenarios) yield a flat response in the ERP Saving across the input range for the input variable.

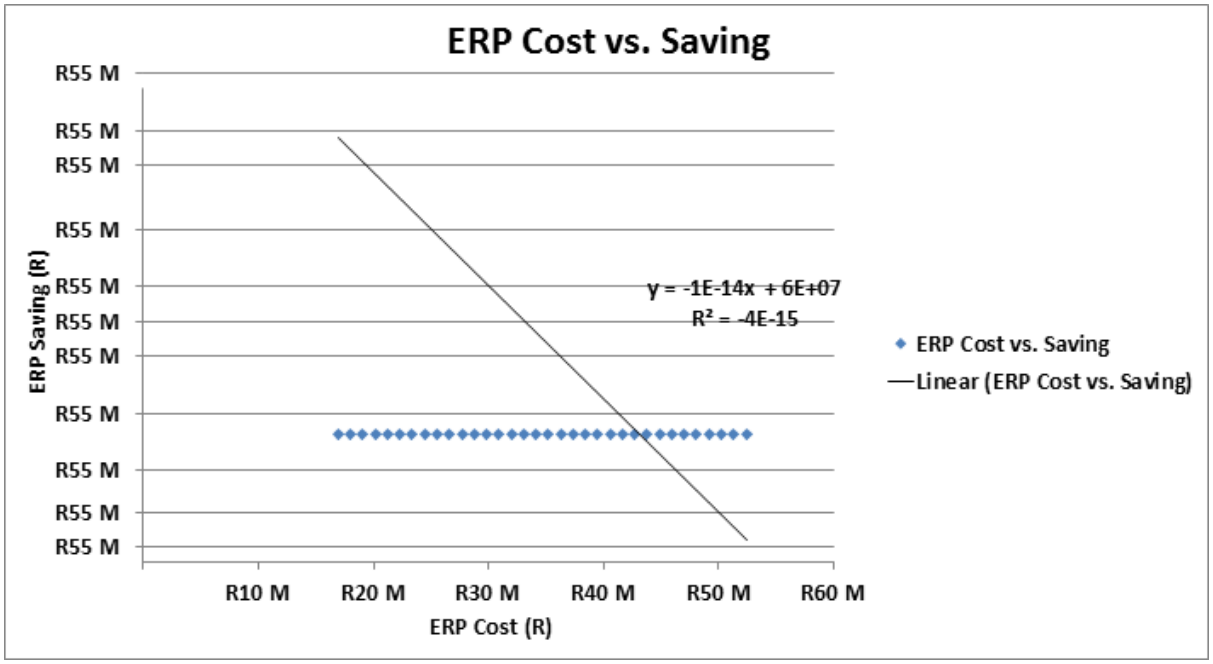

Figure 63: ERP Cost vs. Saving

The other measured output variables yield a predictable (linear) response across the range of the input variable.

What is interesting about the "User License" scenario (as opposed to the "Spend Volume" scenario) is that the correlation between the ERP Cost and the ERP Saving is actually a decreasing function across the range of the input variable.

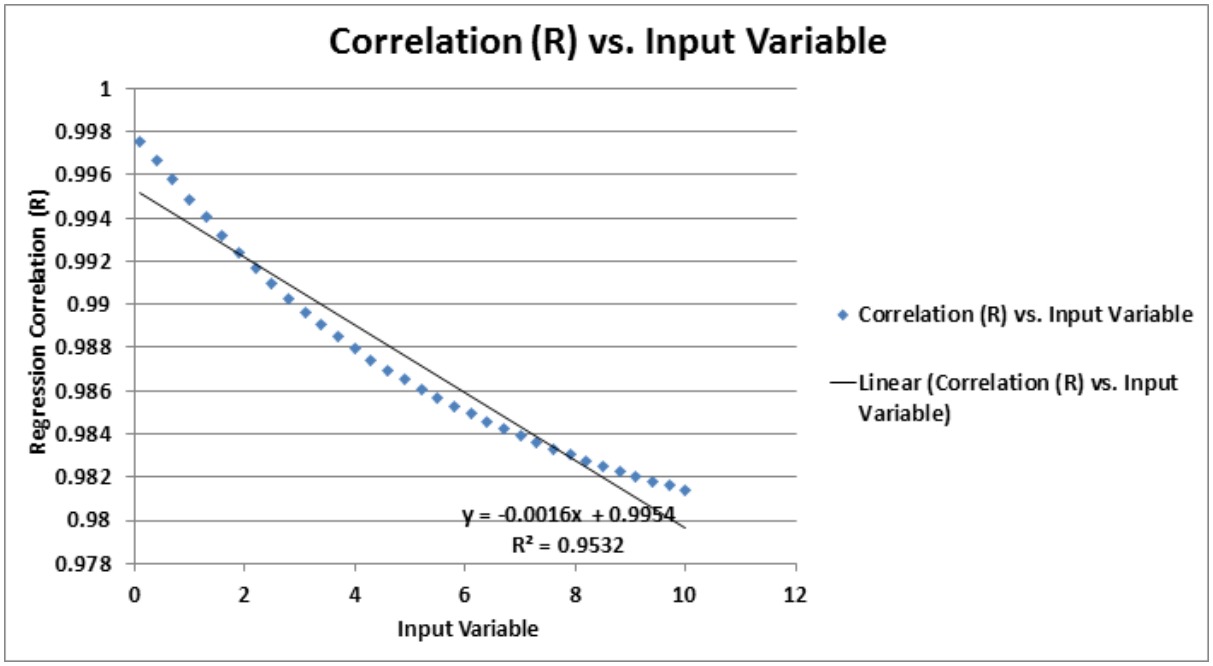

Figure 64: Correlation (R) vs. Input Variable

7.1.9 Scenario 9: Competitiveness Bonus

7.1.9.1 Variable Explanation

In addition to all of the "tangible" benefits that ERP provides, various authors (Dedrick et al., 2003; Gattiker & Goodhue, 2005; Hunton et al., 2003; Nicolaou, 2004; Poston & Grabski, 2004) have documented the "intangible" benefits such as:

- Improved management decision making
- More agility and shorter lead time
- Reduced working capital
- Improved Efficiency
- Improved investor confidence

Although these "intangible" benefits are impossible to isolate on the firm's income statement, they will undoubtedly manifest as some form of "competitive advantage" over non-ERP rivals. This can be likened to receiving a firm-level performance incentive that non-ERP rivals are not entitled to.

The level of intangible benefit experienced is a function of:

- Efficacy of ERP system (user adoption and trust in ERP data)
- ERP Quality (quality of specific ERP package)
- Implementation Quality (quality of ERP implementation at firm)

This scenario aims to encapsulate all these intangible benefits into a financial gain and tests the cost/saving link of the ERP under varying levels of intangible benefits.

The actual variable used ("Competitiveness Bonus") is a percentage addition to the profit that the company realised. The intent of this is to say that the intangible benefits will assist a company to squeeze the last few per cent out of their revenue (by reducing cost, making smarter decisions and so on).

In the baseline model, this bonus was set to a conservative 1%

7.1.9.2 Input Range and Step

Table 16: Scenario Input Range and Step Size

Range	0.1 to 10
Increment	0.3

The variable is stepped from 0.1 to 10 in increments of 0.3. In other words, the scenario simulates that the company would realise profit levels of 100.1% through to 110% of their actual profit over the range of the input variable.

7.1.9.3 Discussion

As with the other "free benefits" of ERP, the ERP Cost is not affected by the input variable at all.

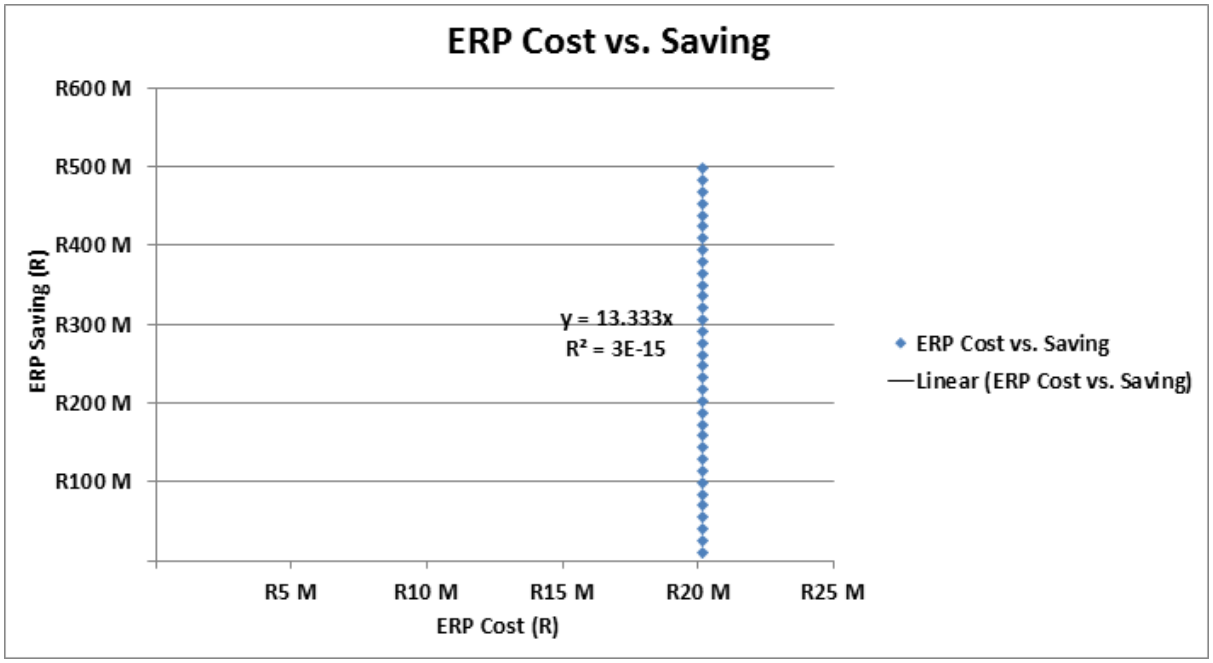

Figure 65: ERP Cost vs. Saving

The other interesting thing to note is that without the competitiveness bonus (or at very low levels), the ERP Net Effect actually dips below zero.

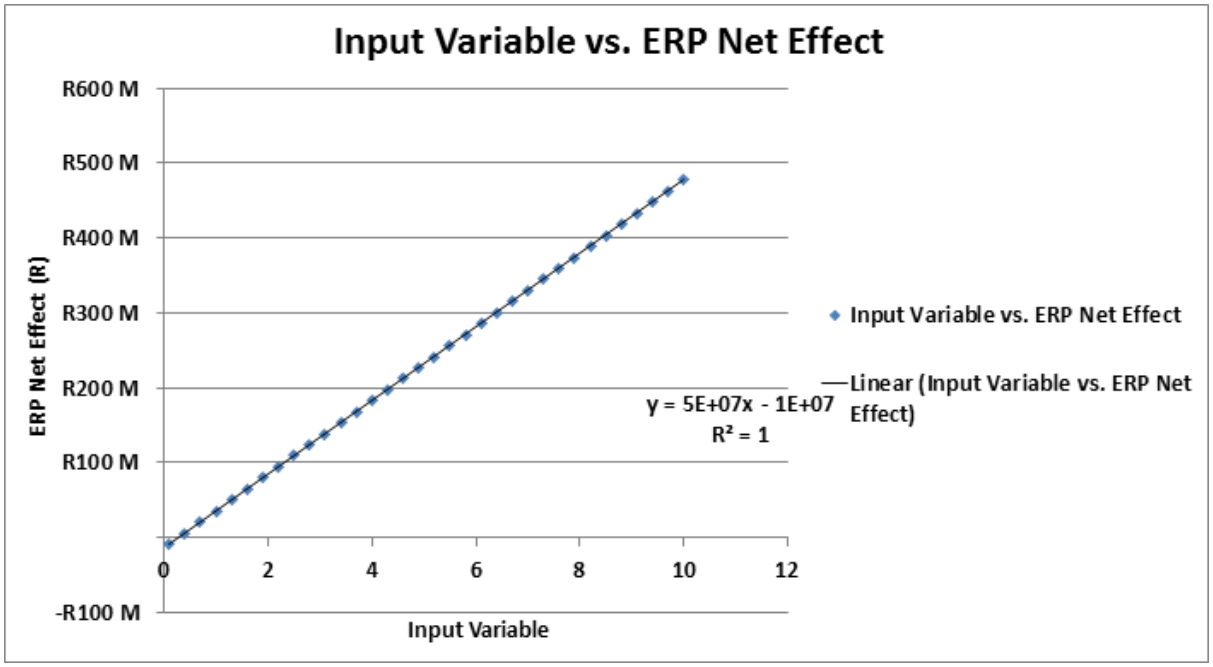

Figure 66: Input Variable vs. ERP Net Effect

Only after the variable reaches 0.4 does the firm start to become profitable over the measurement period.

This unfortunately implies that if a company is not able to realise any of the intangible benefits, the ERP will end up being a pure cost (in this model at least).

The other interesting trend to observe from this scenario is that the correlation between the ERP Cost and ERP saving actually declines as the amount of intangible benefits increase.

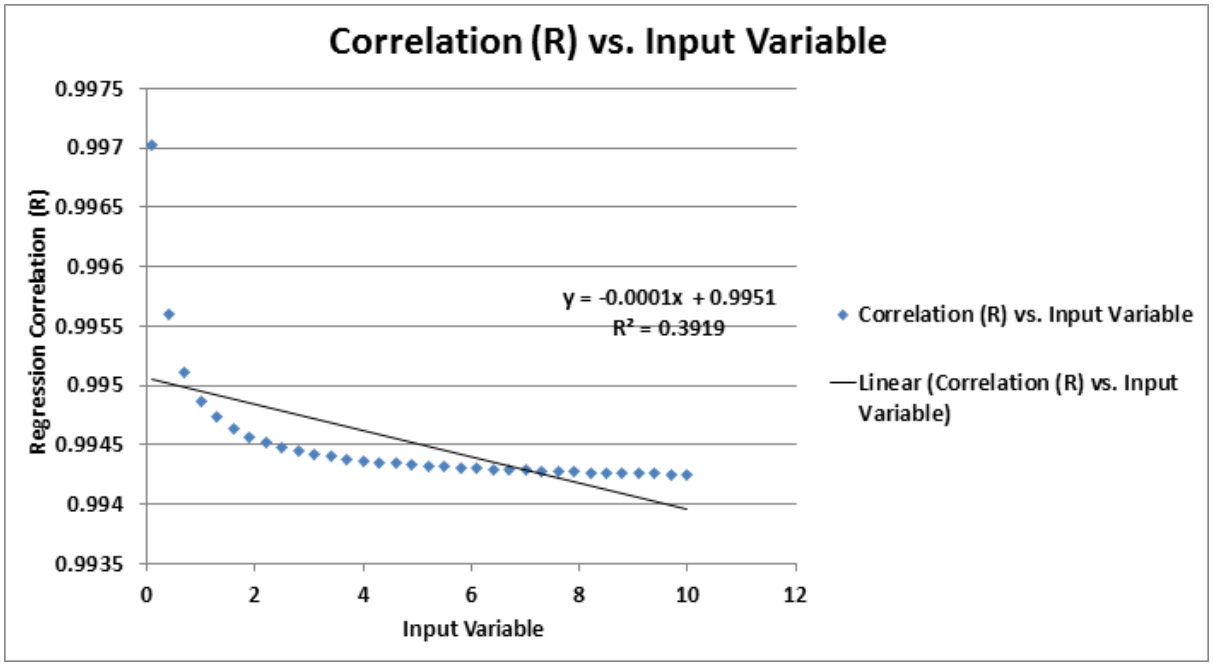

Figure 67: Correlation (R) vs. Input Variable

7.1.10 Scenario 10: Inflation

7.1.10.1 Variable Explanation

The Consumer Price Index (CPI) is an average inflation rate for a grouping (basket) of consumer goods determined by each country. Basic foodstuffs (such as bread) and (non-promotional) salary increases are usually determined and negotiated based on a country's agreed CPI index.

The South African Reserve Bank's (SARB, 2013) published CPI index was built into the base model and used to determine the annual increases on the:

- Salaries of workers in the model
- Sales price of bread (and indirectly the price of raw material)

- Cost of outsourced baking

The aim of this scenario is to test the cost/saving correlation of ERP under varying levels of inflation.

The actual input variable was a multiplier of the SARB published inflation rate per year. This means that if the input variable is 2, each year's published CPI would be multiplied by 2.

7.1.10.2 Input Range and Step

Table 17: Scenario Input Range and Step Size

Range	0.1 to 10
Increment	0.3

The variable was stepped from 0.1 to 10 in increments of 0.3. This initial step (0.1) translates into a level of inflation at a tenth of the actual inflation whereas the last step (10) translates into ten times as high CPI as is actually experienced in South Africa over the measured period.

7.1.10.3 Discussion

The first interesting trend that is visible from this scenario is the fact that (from this model's perspective) elevated inflation seems to be beneficial for bread producers.

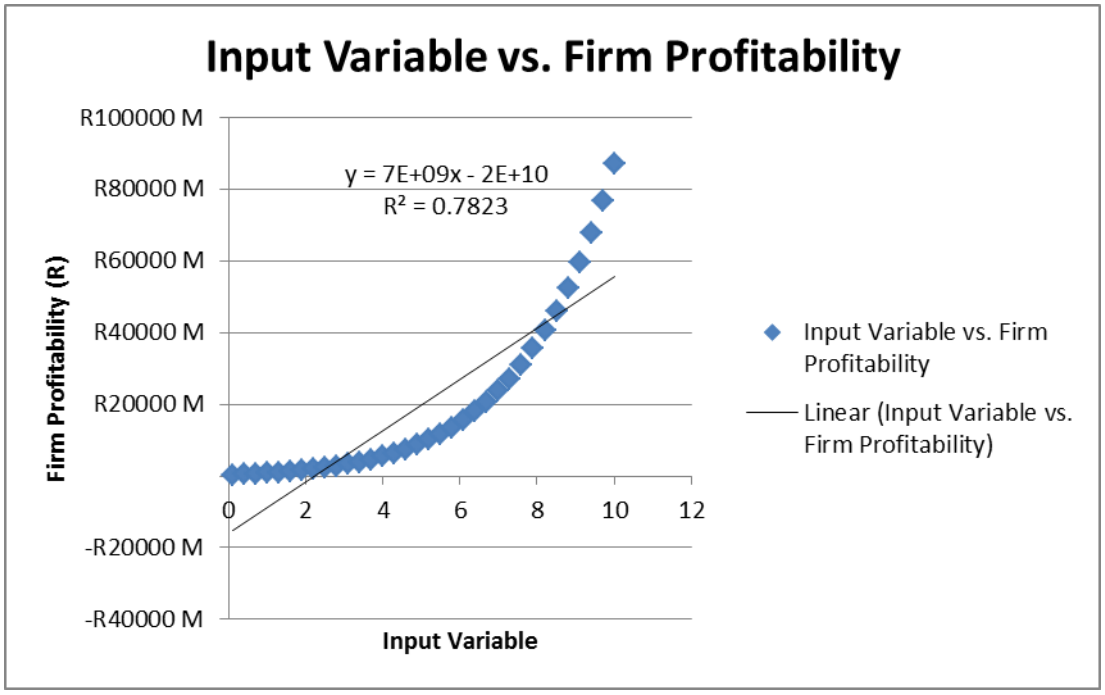

Figure 68: Input Variable vs. Firm Profitability

In reality, the situation will likely play out very differently under extreme inflationary conditions. Consumers will likely switch back to maize and other cheaper staple forms under highly inflationary conditions which will end up hurting bread producers. However, this shortcoming of the model is irrelevant, since the goal is to test the response of the ERP license model under different levels of inflation and not to test consumer sensitivity to inflation.

7.1.11 Scenario 11: Only user license (Order Size var.)

7.1.11.1 Variable Explanation

This scenario does not strictly form part of the main group of scenarios. This serves as an experimental scenario that was set up to simulate a simpler ERP license model (Tier-2 ERP) that consists solely of user-based licenses as opposed to the complex license structure used by the Tier-1 ERP systems.

In this scenario, the effect of the other license types were neutralised (set to 0) allowing only for the cost of additional user licenses to reflect as the ERP cost. This simulates the behaviour of an ERP with user licenses only.

The input variable that was used in this scenario is the same "Order Size" multiplier as found in Scenario 2. This means that this scenario is actually a repeat of Scenario 2 using a Tier-2 ERP license model.

7.1.11.2 Input Range and Step

Table 18: Scenario Input Range and Step Size

Range	10 to 400
Increment	10

The variable was stepped from 10 to 400 (exactly as in the other "Order Size" scenario) in increments of 10. Since the baseline model has a value of 100 for this input variable, the range will simulate order sizes from a tenth of the baseline model's through to four times as much as the baseline model.

7.1.11.3 Discussion

The most interesting trend to emerge from this experimental scenario is the fact that most of the measured output variables have very similar responses to Scenario 2, which was essentially the same Simulation with a Tier-1 license model.

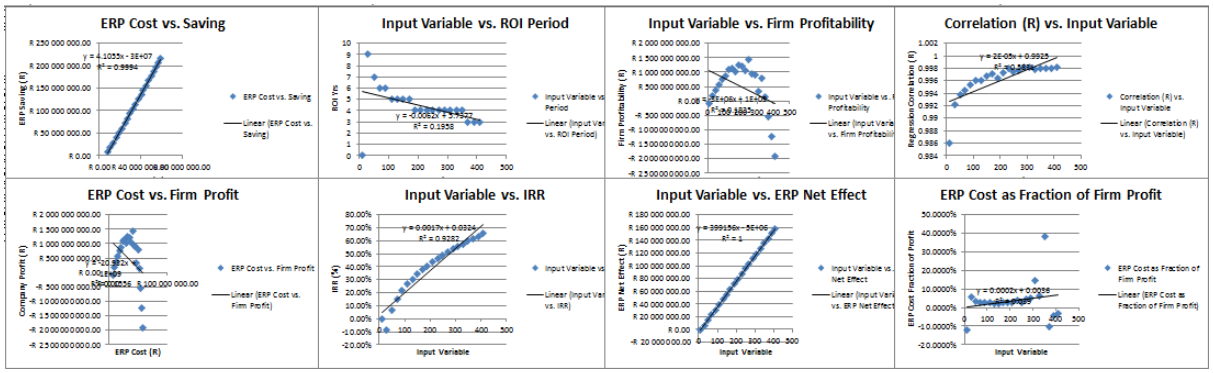

Figure 69: Scenario 2 - Order Size with Tier-1 License Model

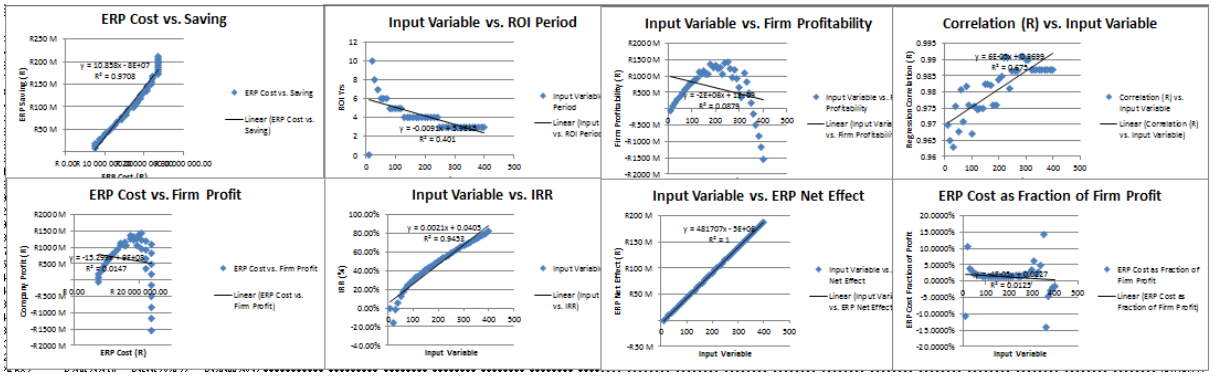

Figure 70: Scenario 12 - Order Size with Tier-2 License Model

Assuming that the high level of complexity built into Tier-1 ERP license models are supposed to align ERP Cost and Value, this result seems to suggest that the same (or very close to the same) result is possible with only user licenses.

The one measured output that showed a significantly different result over the range of the input variable was the level of "correlation" (between ERP Cost and ERP Saving). In the Scenario with the Tier-1 license model, this trend of the correlation exhibited a deterministic function (top half of a sigmoid curve tending to 1).

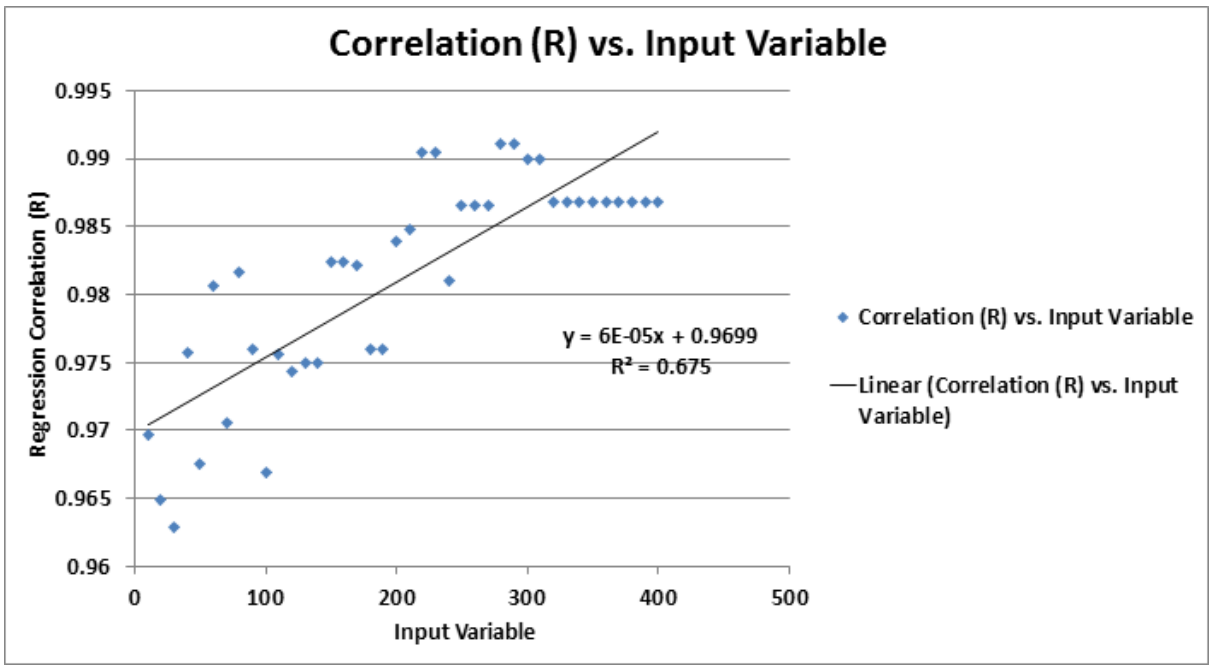

Figure 71: Correlation (R) vs. Input Variable

In this scenario, the correlation output variable exhibits a more randomised function that has a linear regression correlation coefficient of 0.675. This is not completely random, but certainly less deterministic than any of the trends observed in the correlation of the previous scenarios.

This apparent randomisation of the correlation could be attributed to the loss of measurement granularity that associated with the "User-License only" model. In other words, in a Tier-1 license model, every additional sales order or Rand spent would add (a tiny amount) to the license cost, whereas the "User-License only" license model would only add (a large amount) onto the license cost. However, it would only do so each time an additional user license is purchased.

The implication of this is that larger organisations (with more employees) should have a more closely correlated ERP Cost vs. ERP Saving than a smaller organisation with only one or two ERP users. This is ironic, seeing that smaller organisations typically have ERPs with simpler license models such as the "User-License only" model demonstrated above.

8 APPENDIX C – SIMULATION RESULT CHARTS

This appendix details the input ranges and comprehensive results from each of the computer simulation scenarios. For detailed discussion of the results, please see the previous Appendix.

8.1.1 Results

8.1.1.1 Scnenario1: Raw material cost below sales price

8.1.1.1.1 Input Range and Step

Table 19: Scenario Input Range and Step Size

Range	0.05 to 0.9
Increment	0.03

The variable was adjusted in increments of 0.03 (3%) from 0.05 (5%) to 0.9 (90%).

In other words this compares the extremes where raw material costs 90% less than the sales price through to the point where raw material costs only 3% less than the sales price

8.1.1.1.2 Results

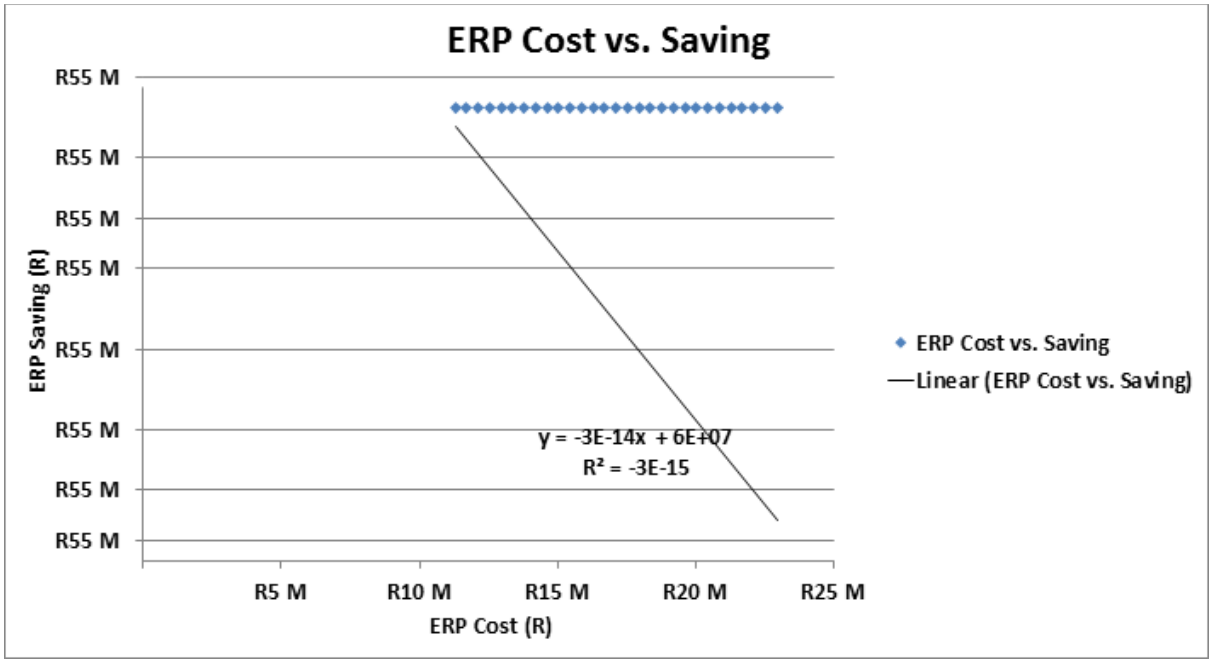

Figure 72: ERP Cost vs. Saving

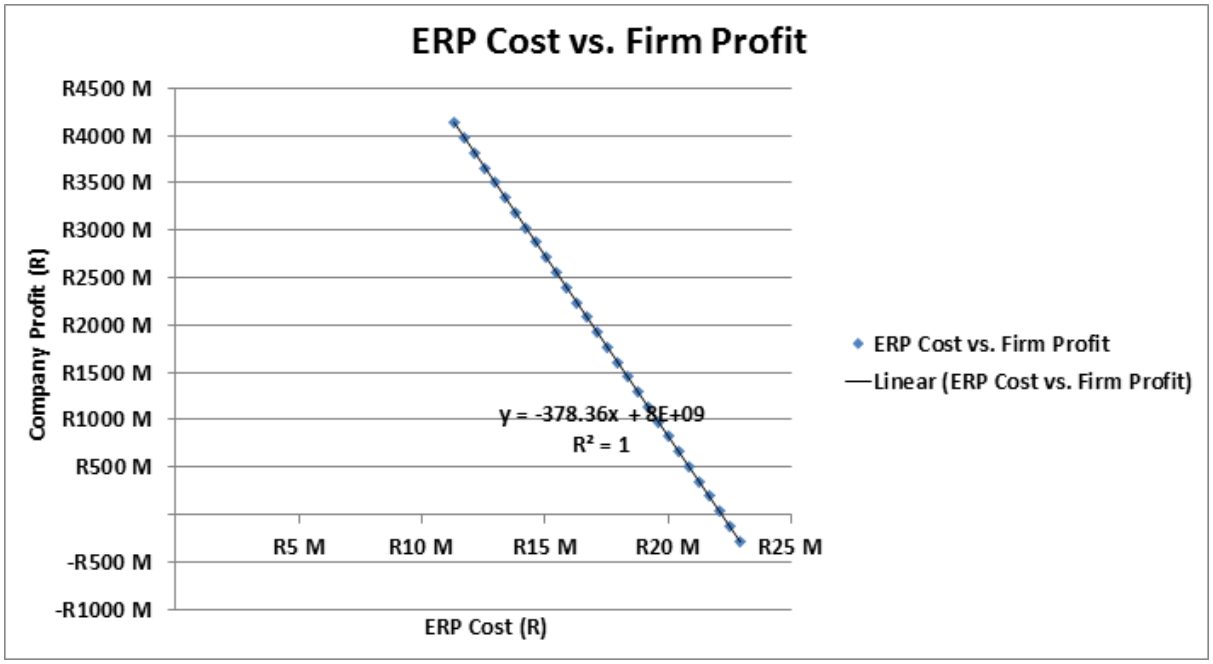

Figure 73: ERP Cost vs. Firm Profit

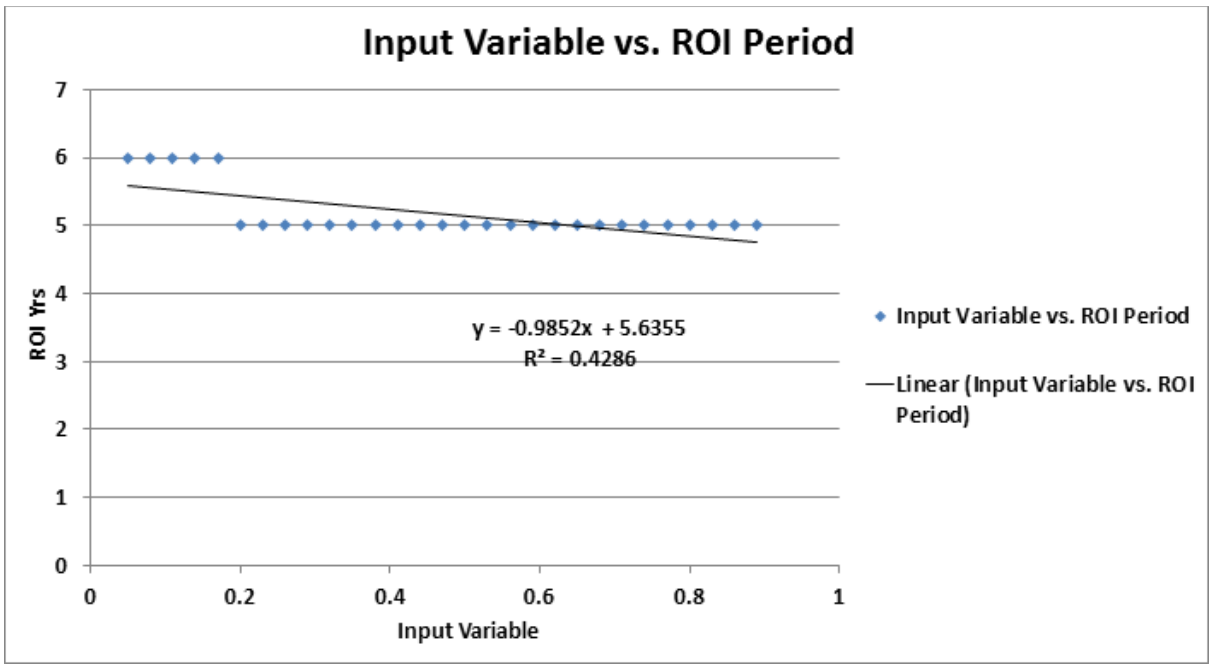

Figure 74: Input Variable vs. ROI Period

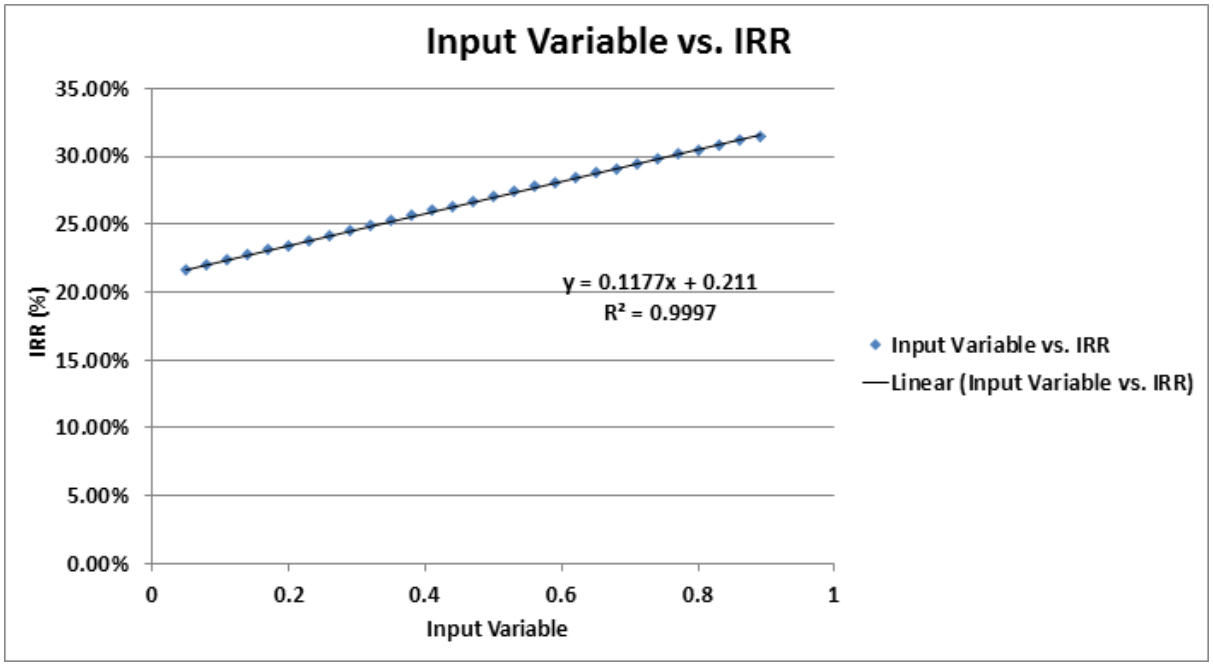

Figure 75: Input Variable vs. IRR

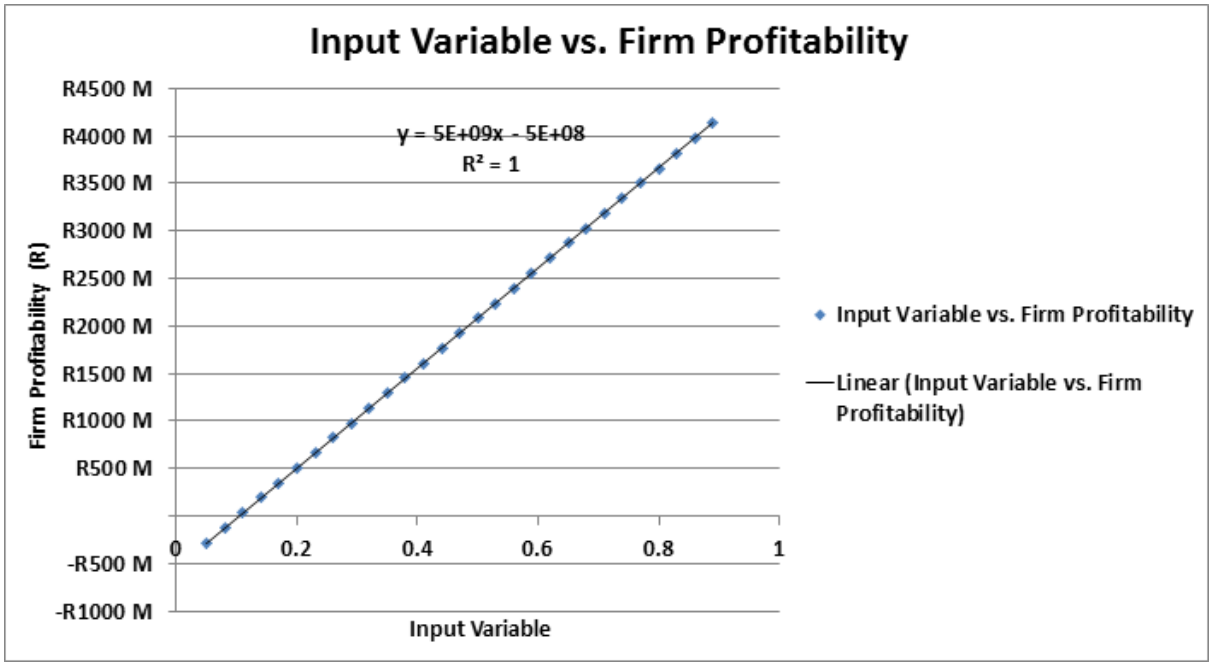

Figure 76: Input Variable vs. Firm Profitability

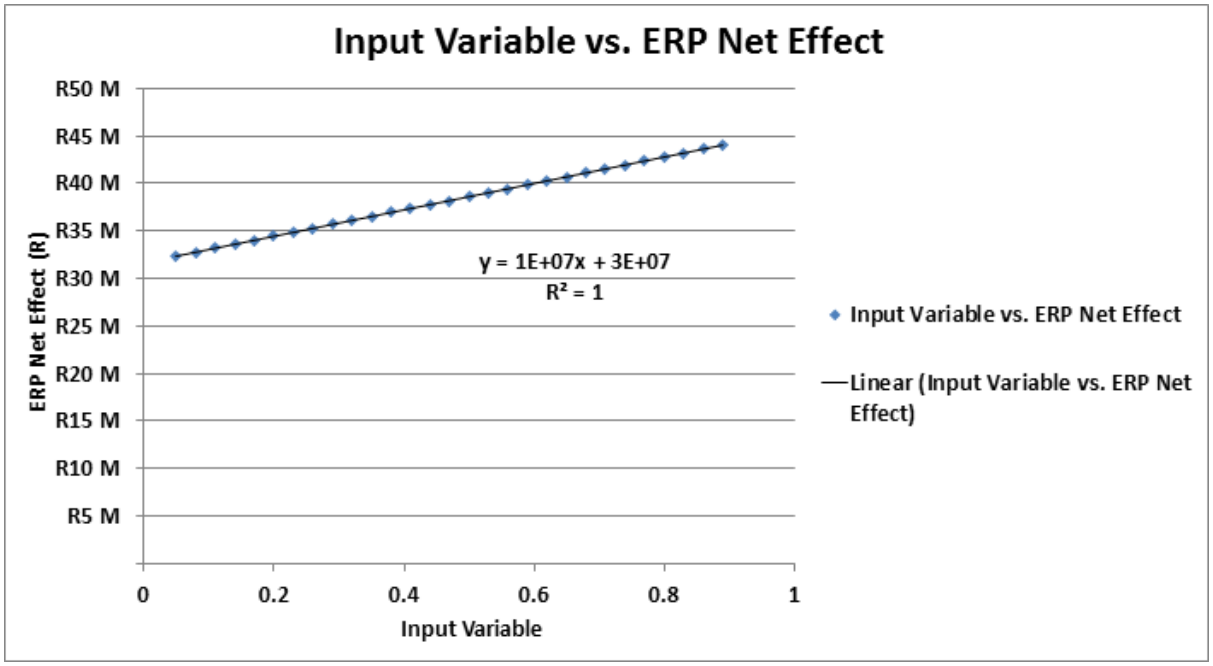

Figure 77: Input Variable vs. ERP Net Effect

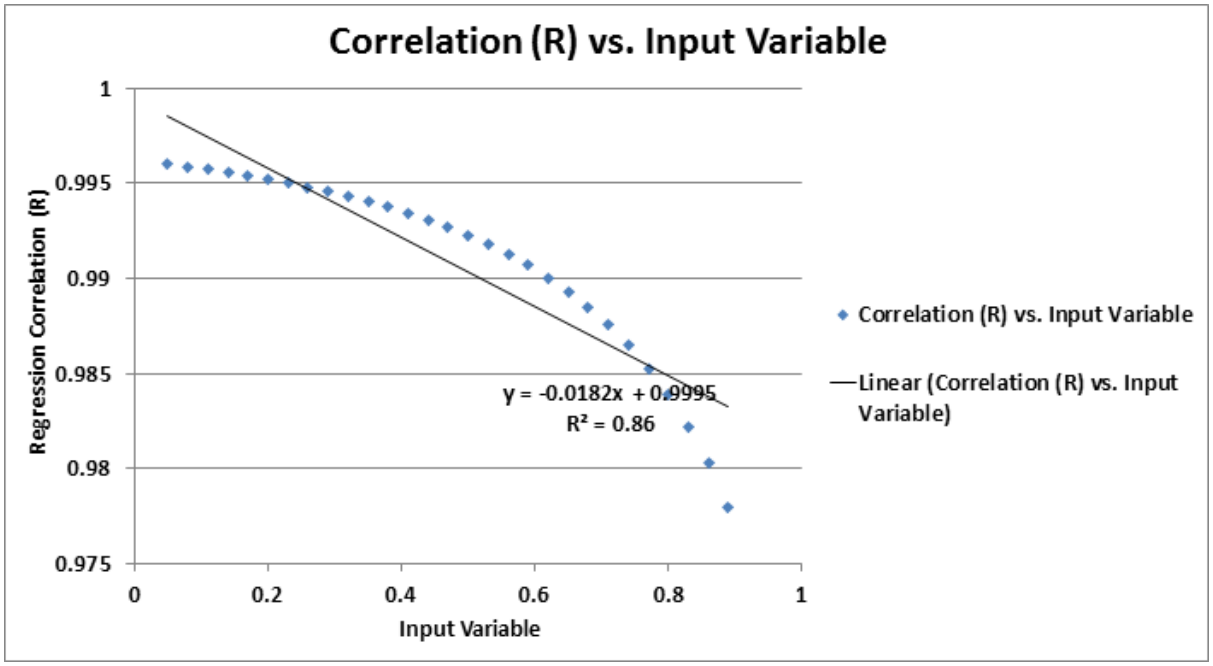

Figure 78: Correlation (R) vs. Input Variable

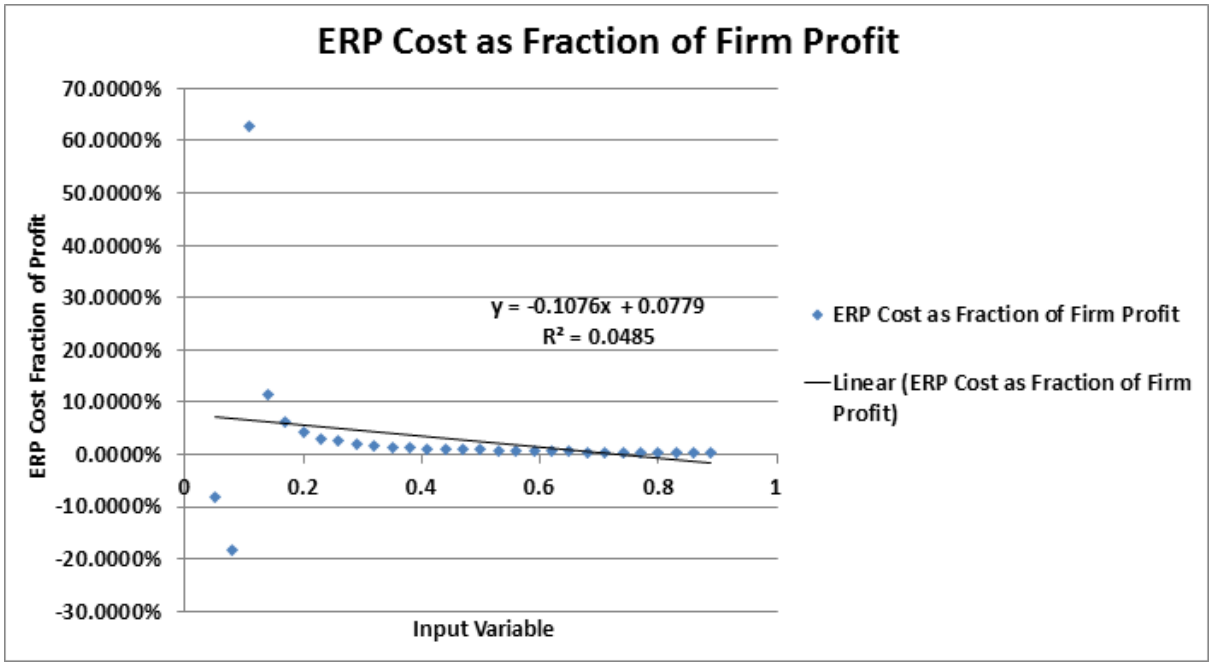

Figure 79: ERP Cost as Fraction of Firm Profit

8.1.1.2 Scnenario2: Order Size

8.1.1.2.1 Input Range and Step

Table 20: Scenario Input Range and Step Size

Range	10 to 400
Increment	20

The variable was varied from 10 to 400. In other words, the starting point simulates absolutely no orders and the final step simulates 400 times as many orders as the input data would assume or four times as many orders as were assumed in the baseline model.

The baseline level for this variable was 100.

8.1.1.2.2 Results

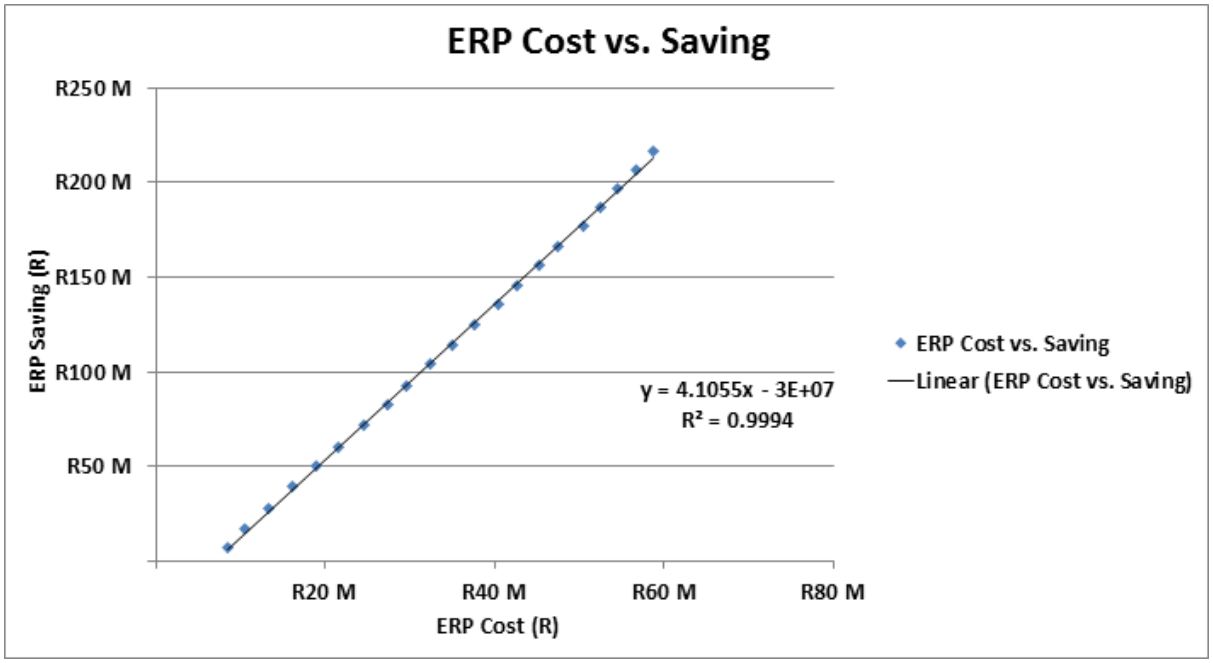

Figure 80: ERP Cost vs. Saving

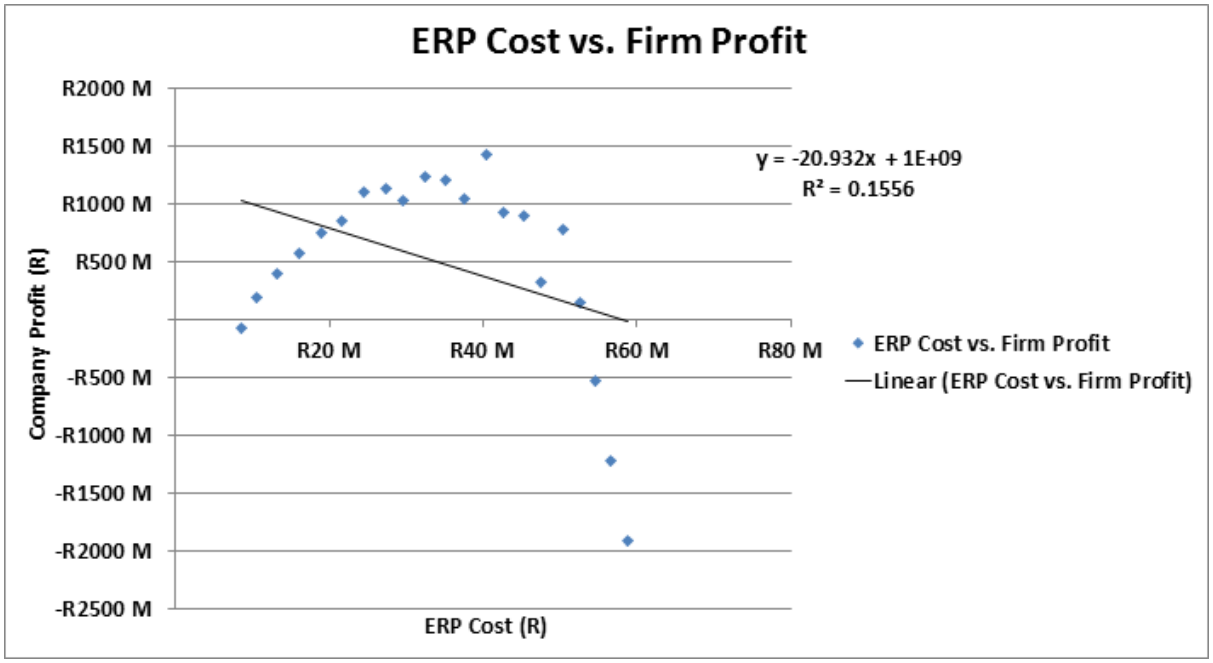

Figure 81: ERP Cost vs. Firm Profit

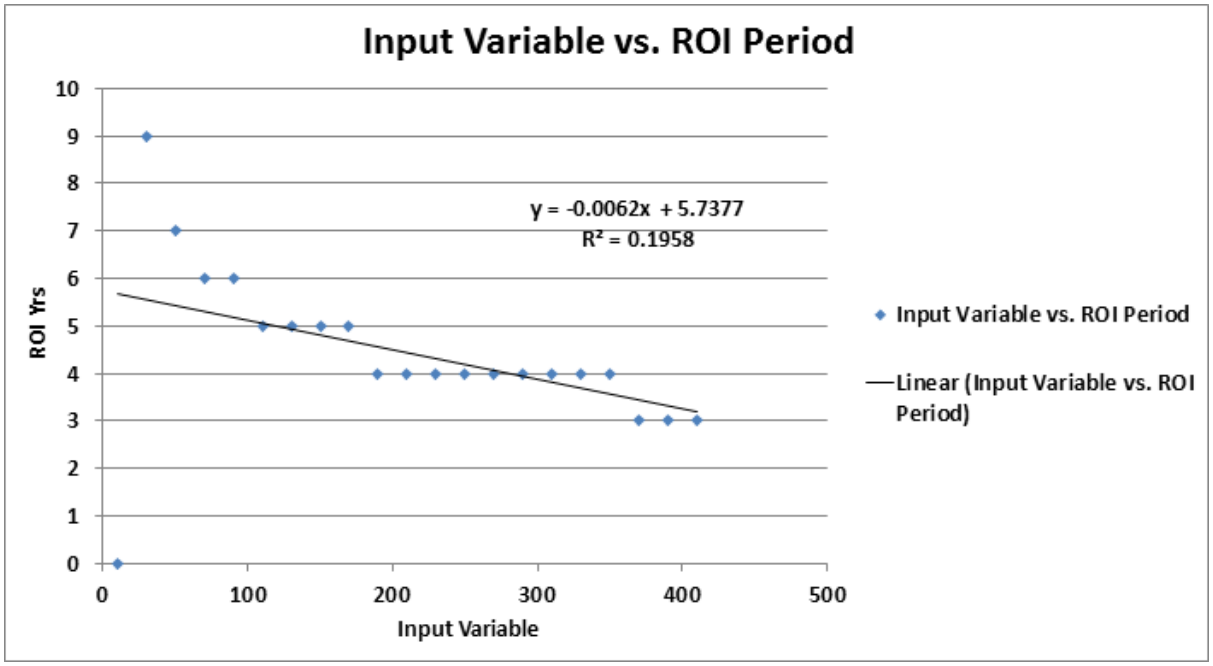

Figure 82: Input Variable vs. ROI Period

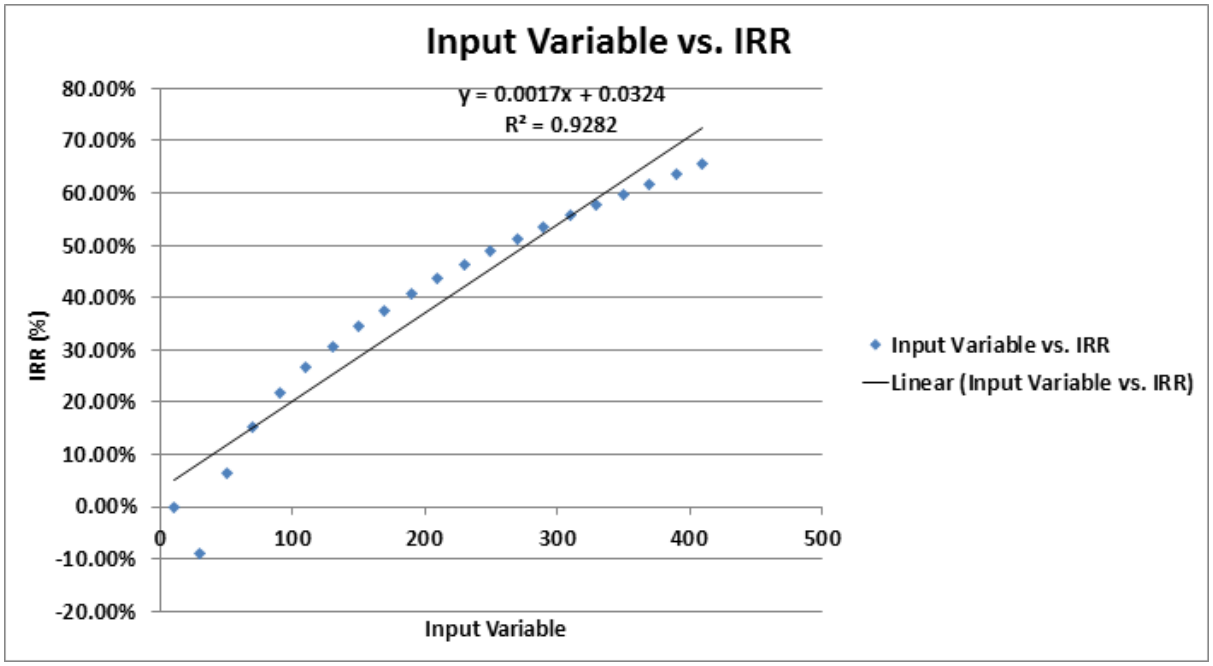

Figure 83: Input Variable vs. IRR

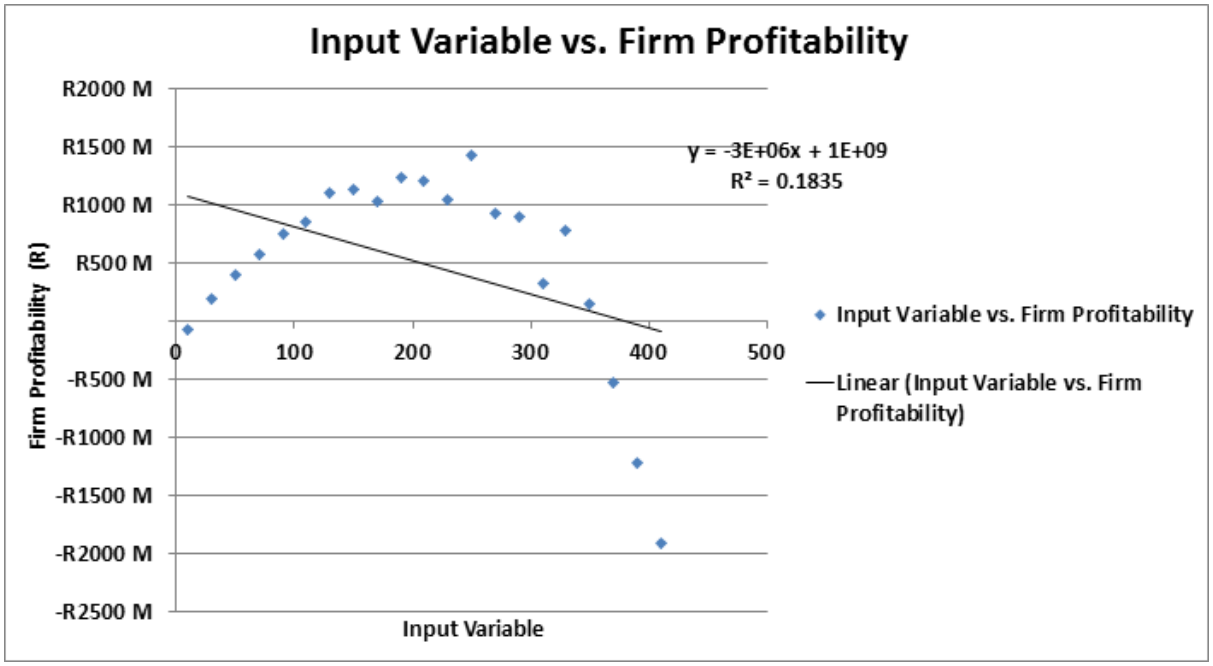

Figure 84: Input Variable vs. Firm Profitability

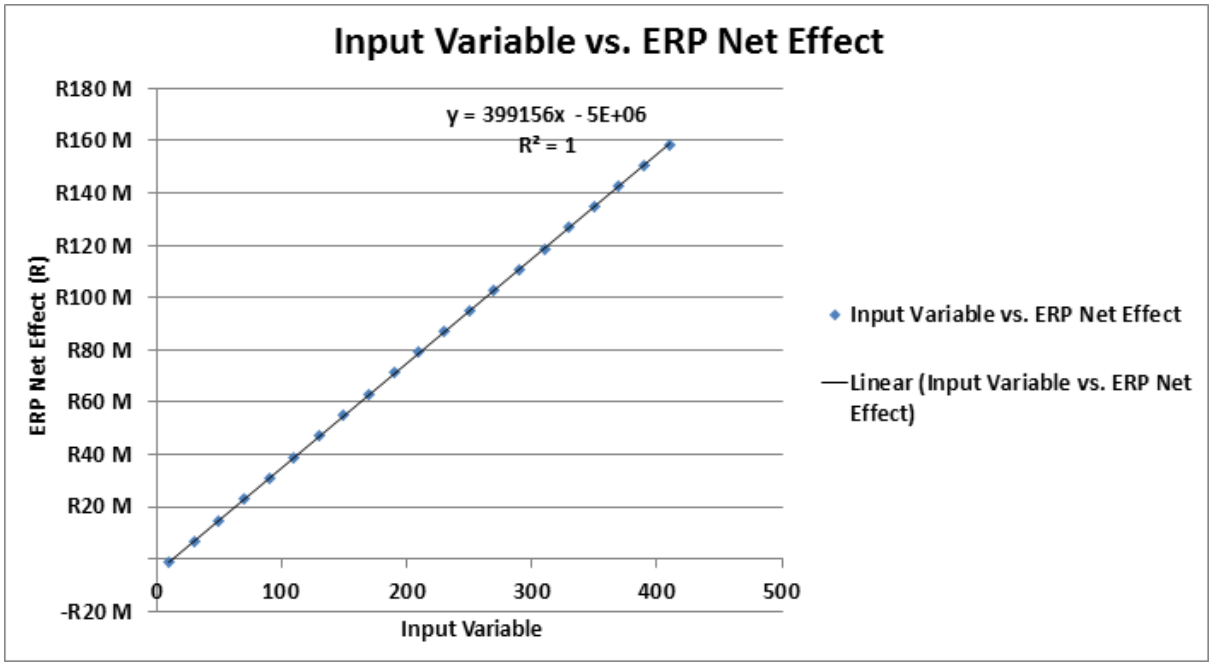

Figure 85: Input Variable vs. ERP Net Effect

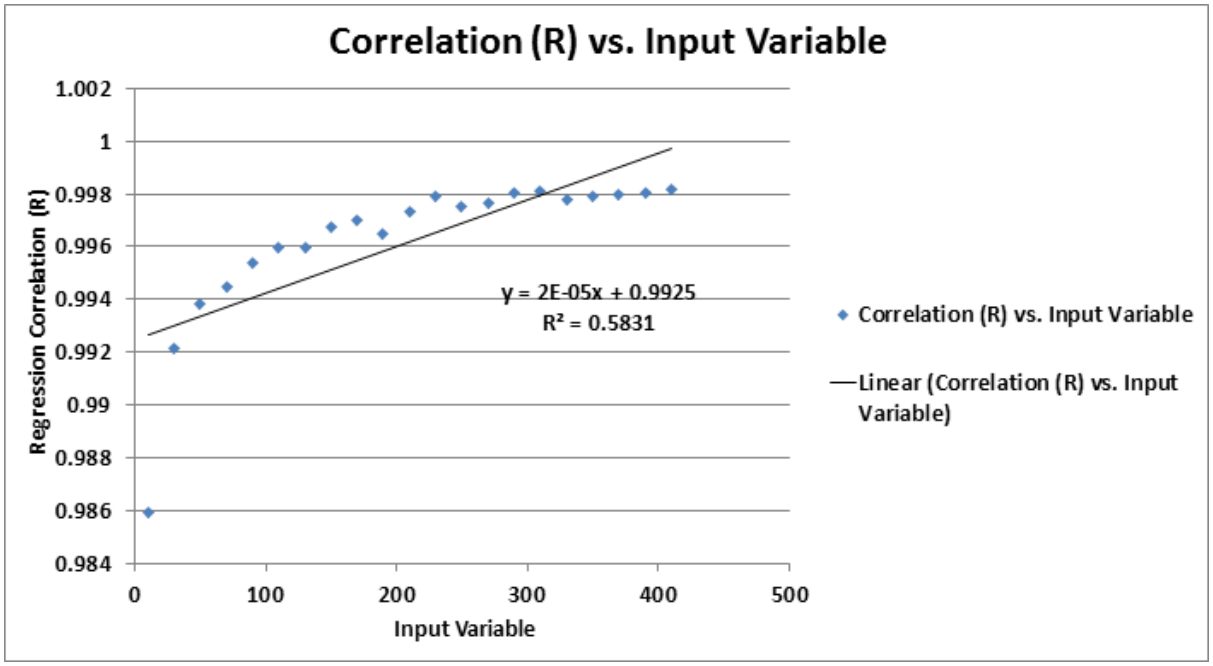

Figure 86: Correlation (R) vs. Input Variable

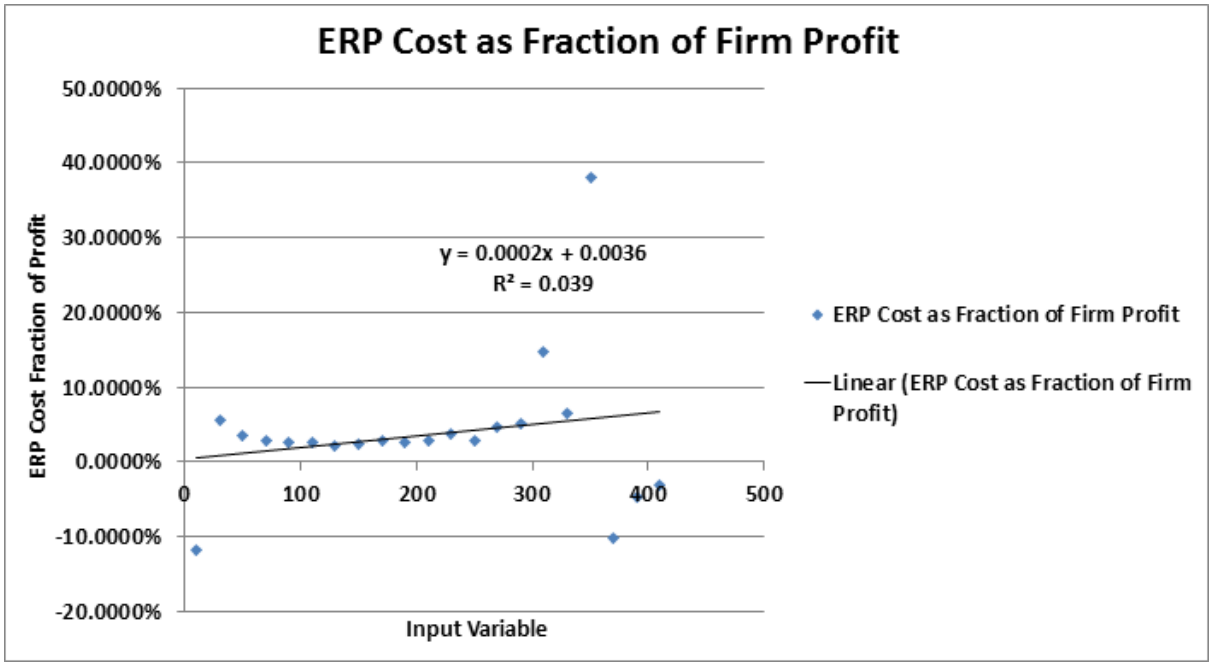

Figure 87: ERP Cost as Fraction of Firm Profit

8.1.1.3 Scnenario3: Base Price

8.1.1.3.1 Input Range and Step

Table 21: Scenario Input Range and Step Size

Range	1 to 10

Increment	0.3

8.1.1.3.2 Results

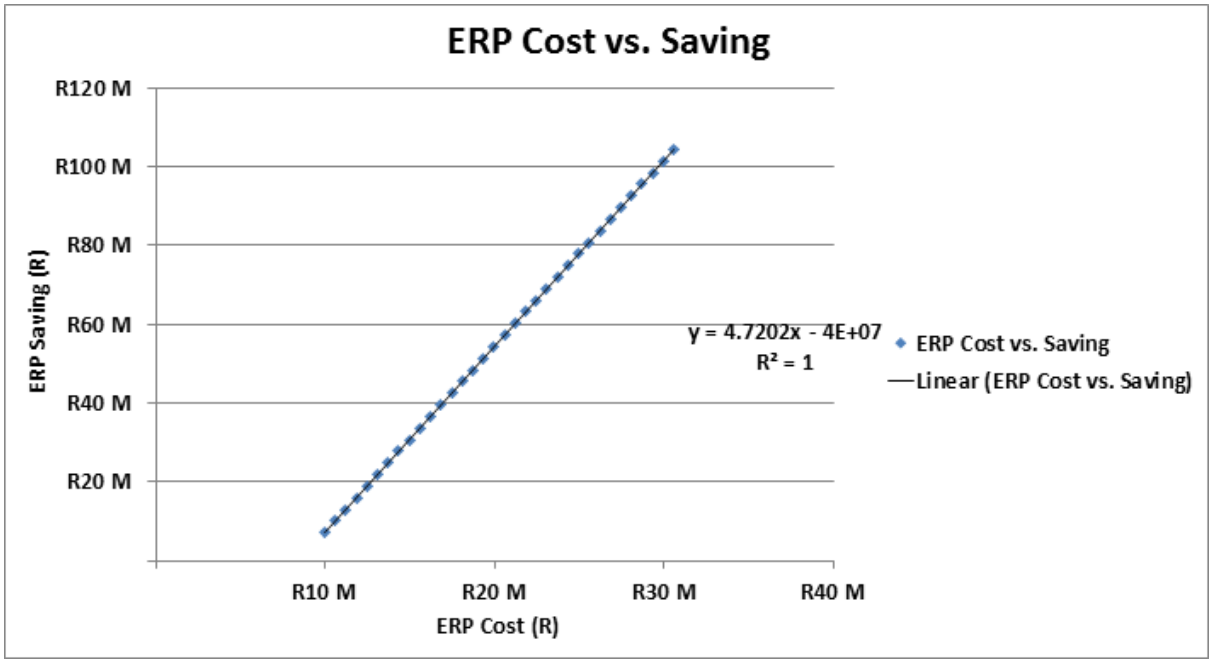

Figure 88: ERP Cost vs. Saving

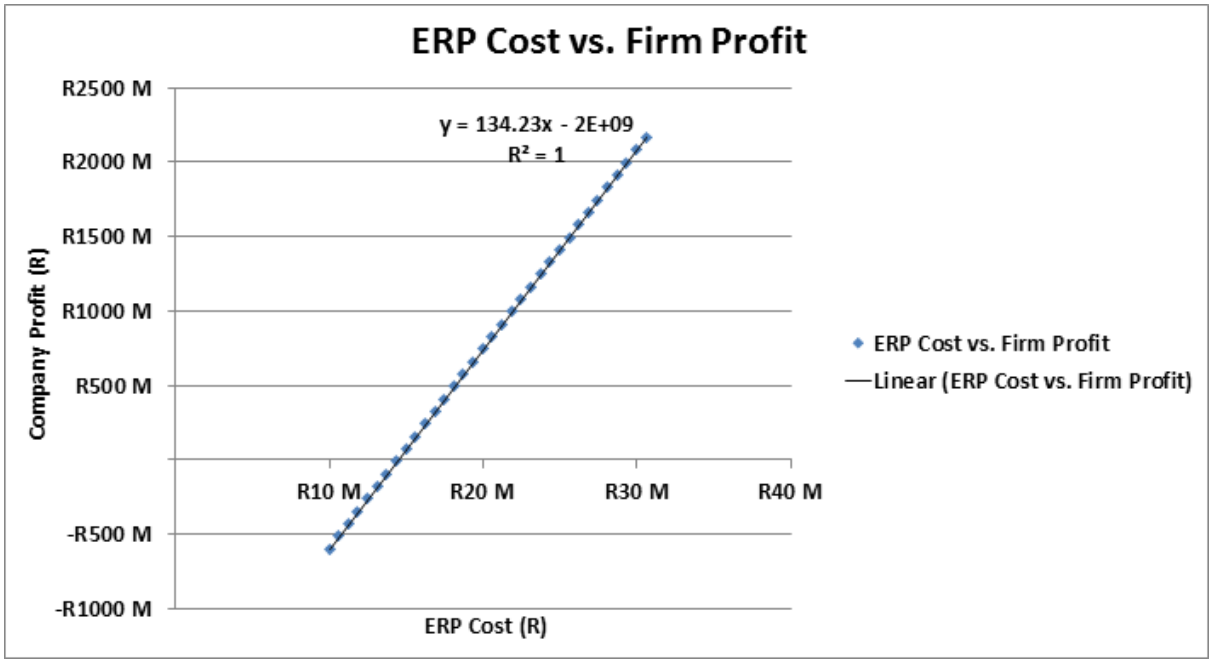

Figure 89: ERP Cost vs. Firm Profit

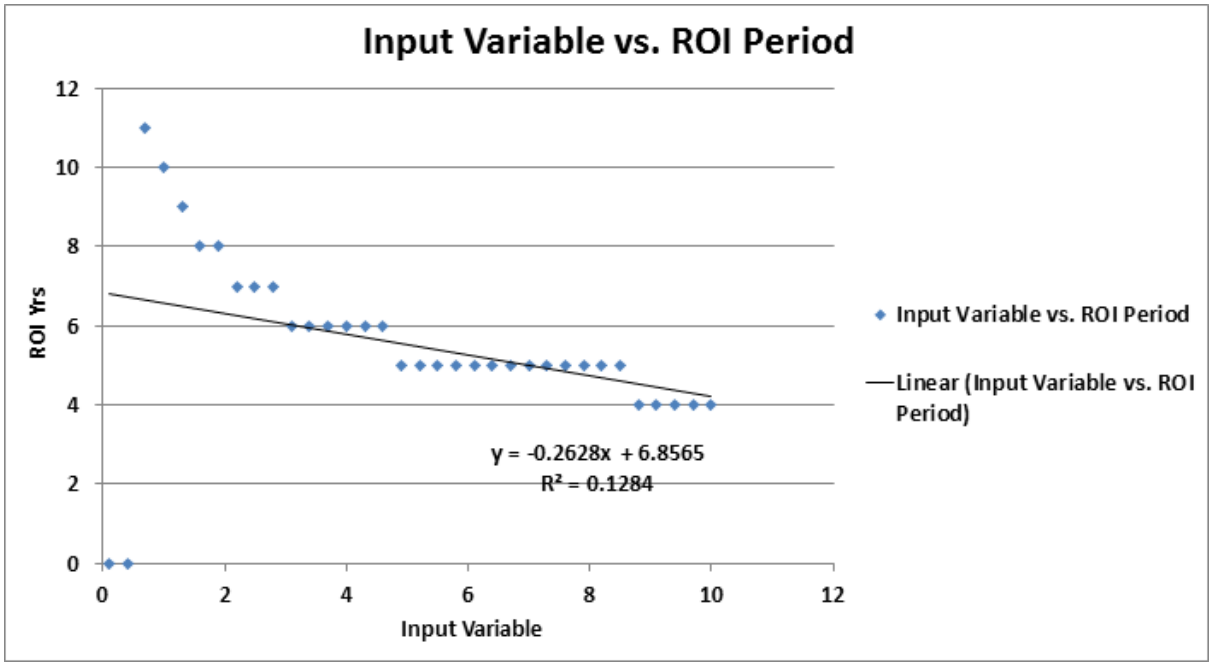

Figure 90: Input Variable vs. ROI Period

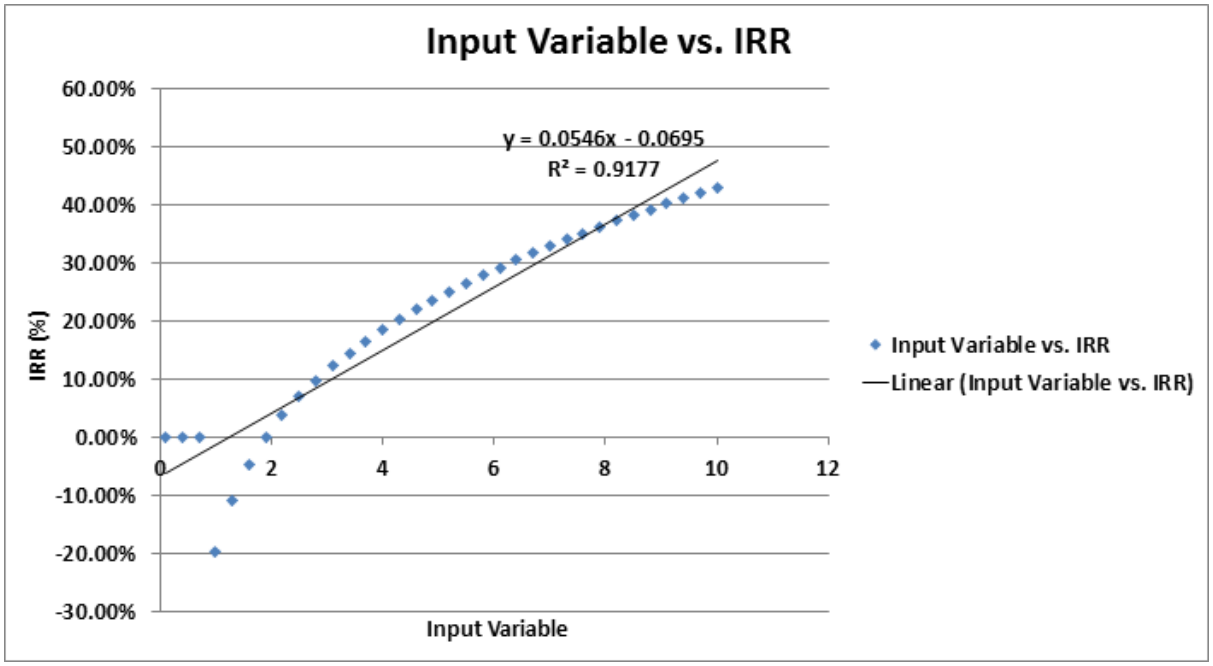

Figure 91: Input Variable vs. IRR

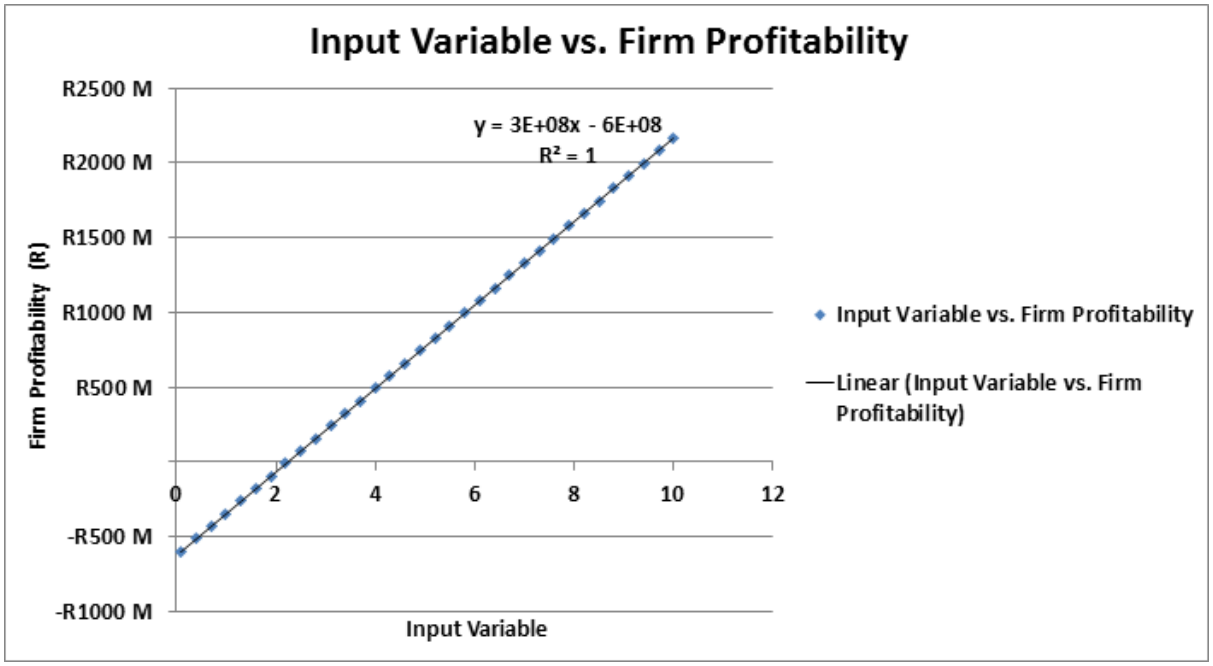

Figure 92: Input Variable vs. Firm Profitability

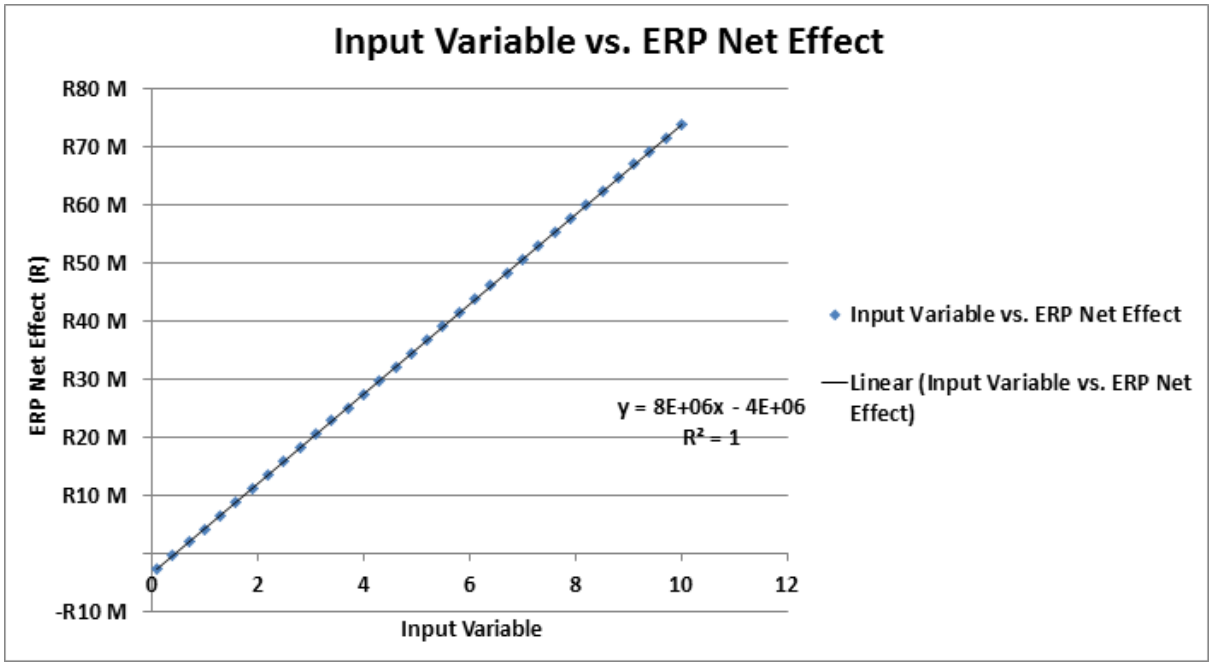

Figure 93: Input Variable vs. ERP Net Effect

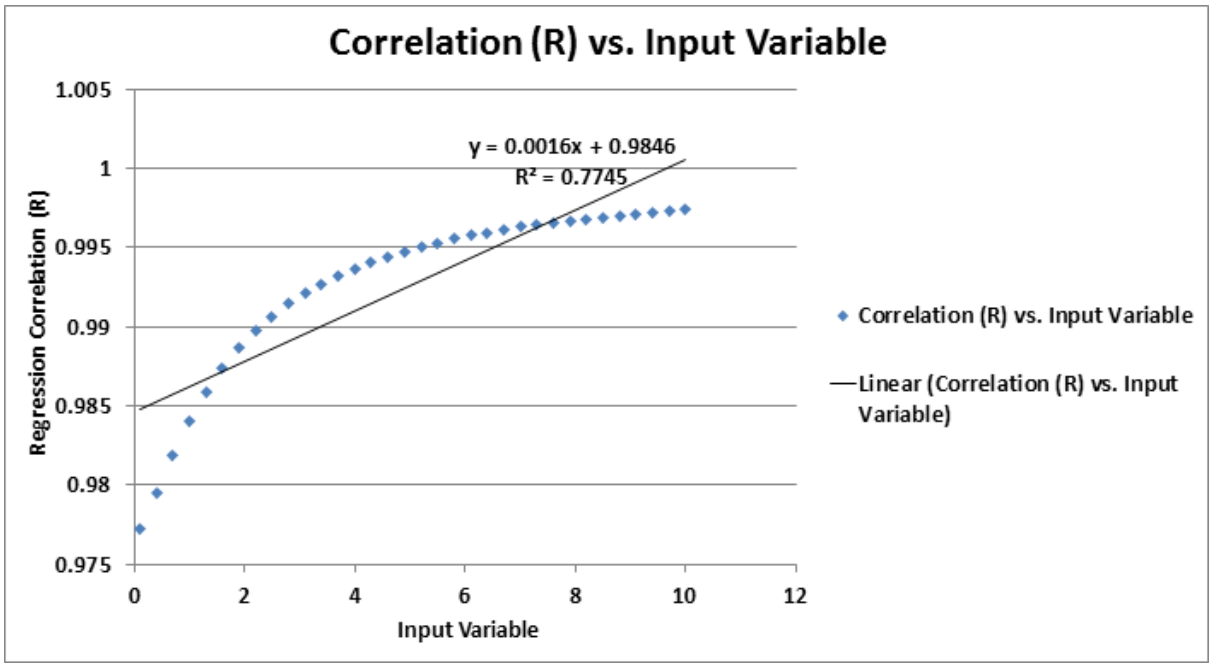

Figure 94: Correlation (R) vs. Input Variable

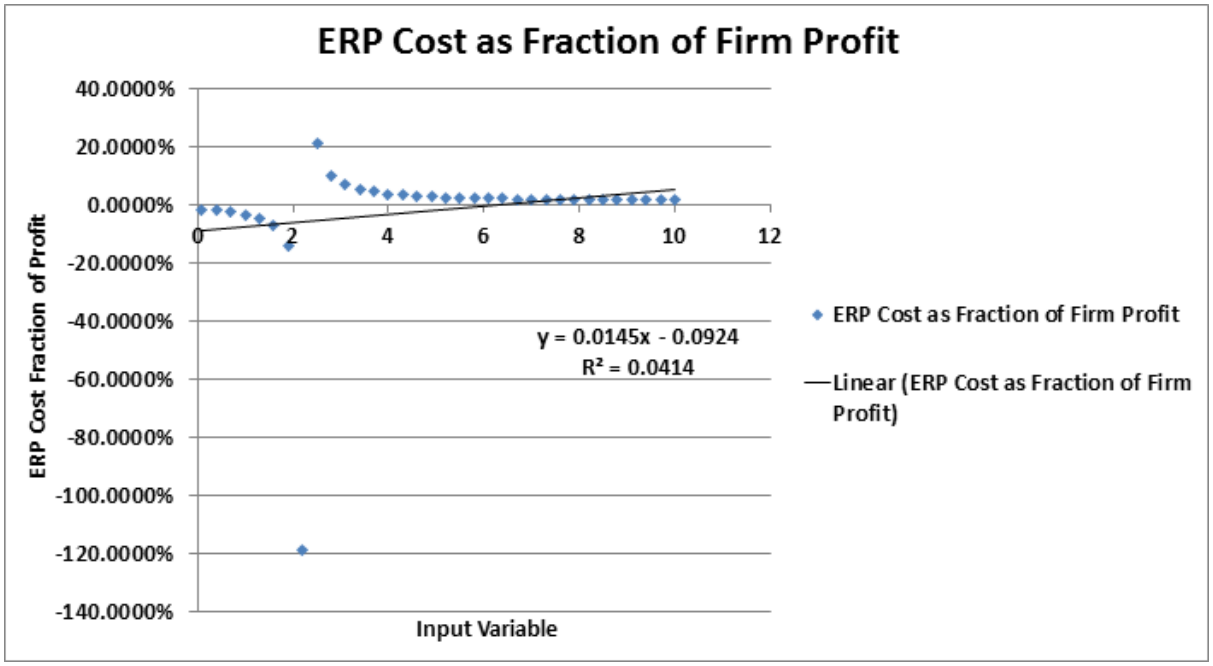

Figure 95: ERP Cost as Fraction of Firm Profit

8.1.1.4 Scnenario4: Outsource Baking Cost

8.1.1.4.1 Input Range and Step

Table 22: Scenario Input Range and Step Size

Range	1 to 20
Increment	1

This essentially means that the cost of outsource baking is varied from R1 (which is much cheaper than the cost at which the bakery can produce bread) to R20 (which is much more expensive than the price at which the bread is sold).

8.1.1.4.2 Results

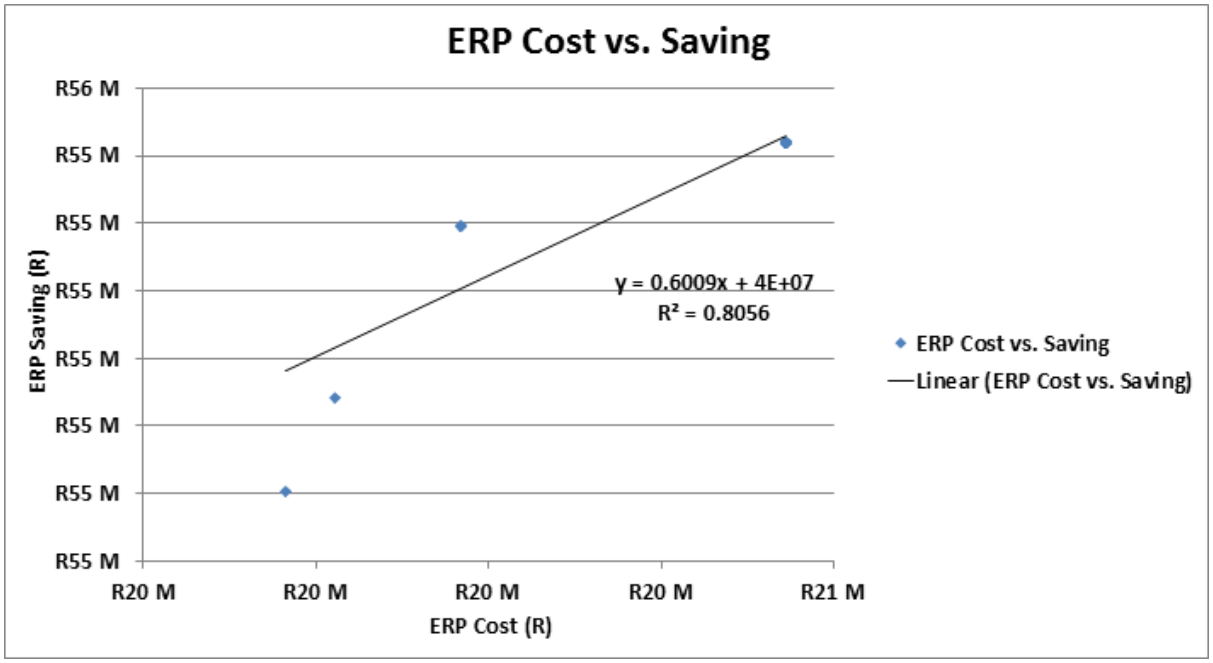

Figure 96: ERP Cost vs. Saving

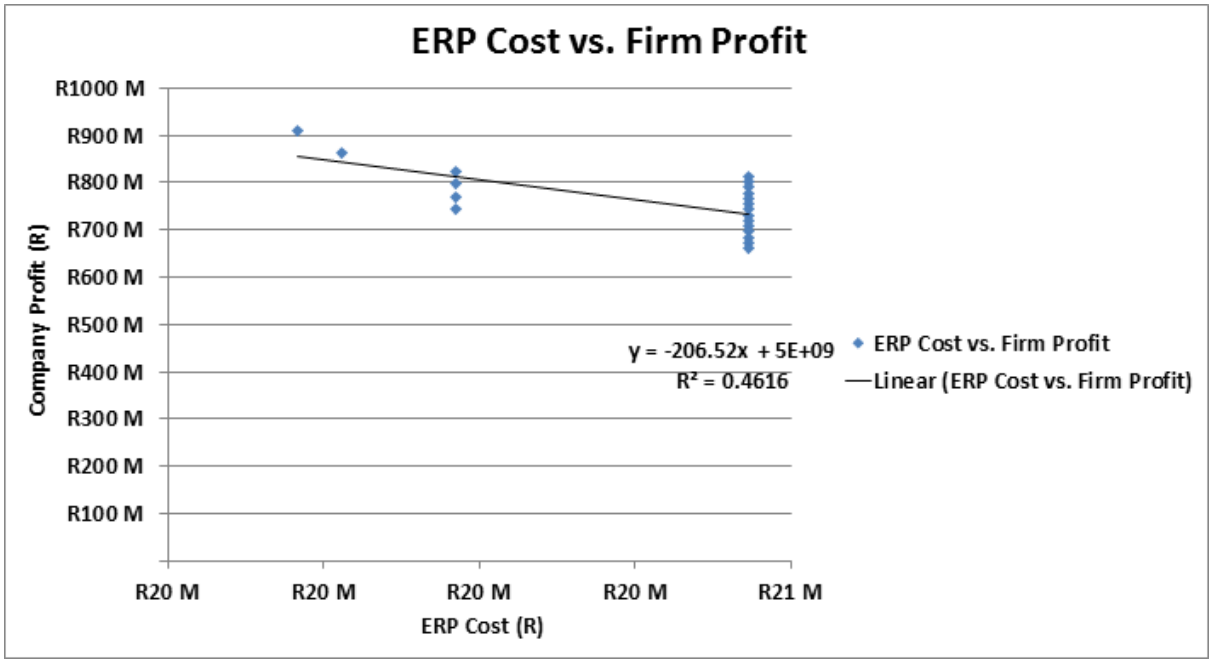

Figure 97: ERP Cost vs. Firm Profit

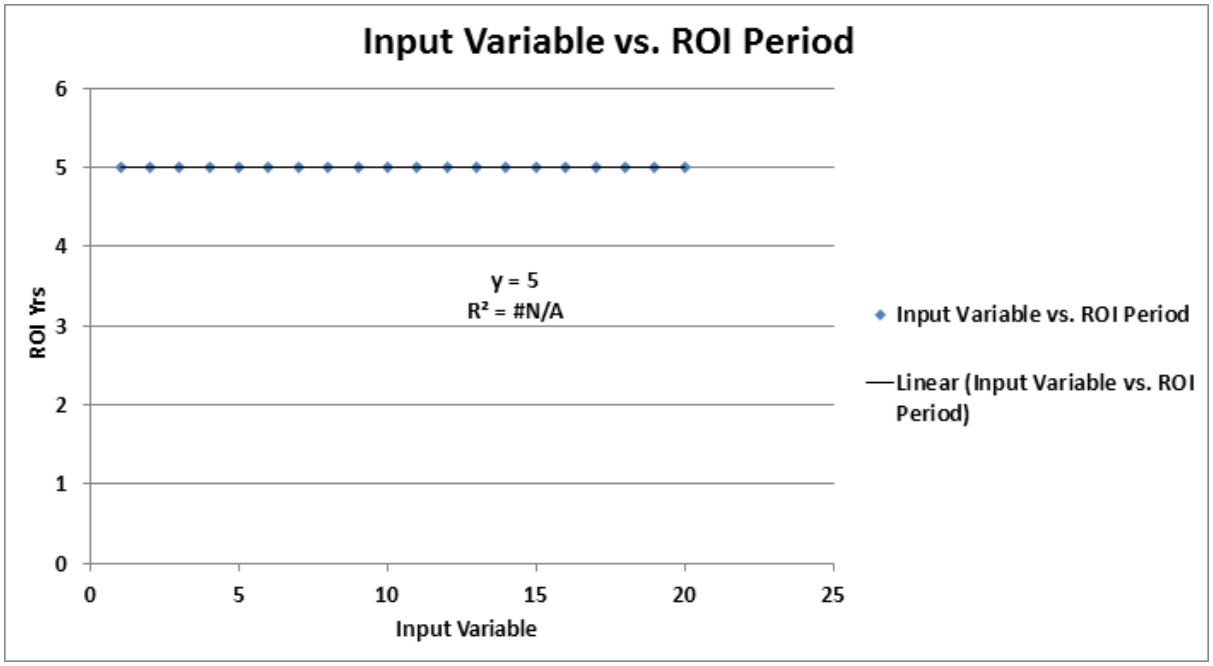

Figure 98: Input Variable vs. ROI Period

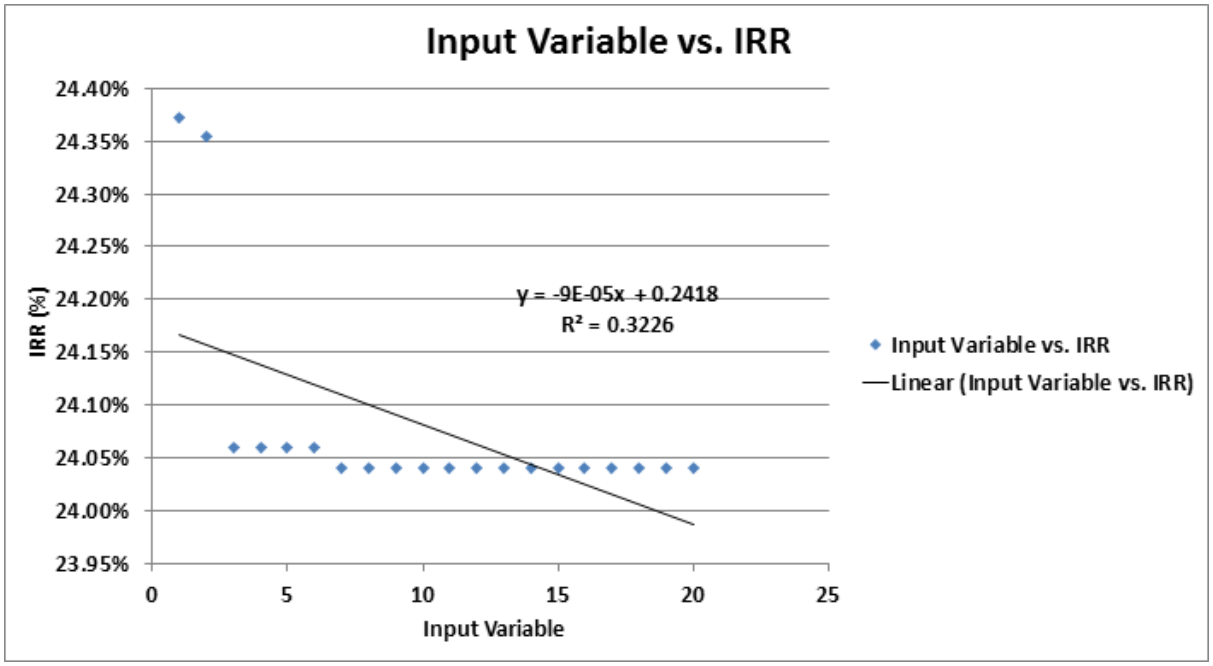

Figure 99: Input Variable vs. IRR

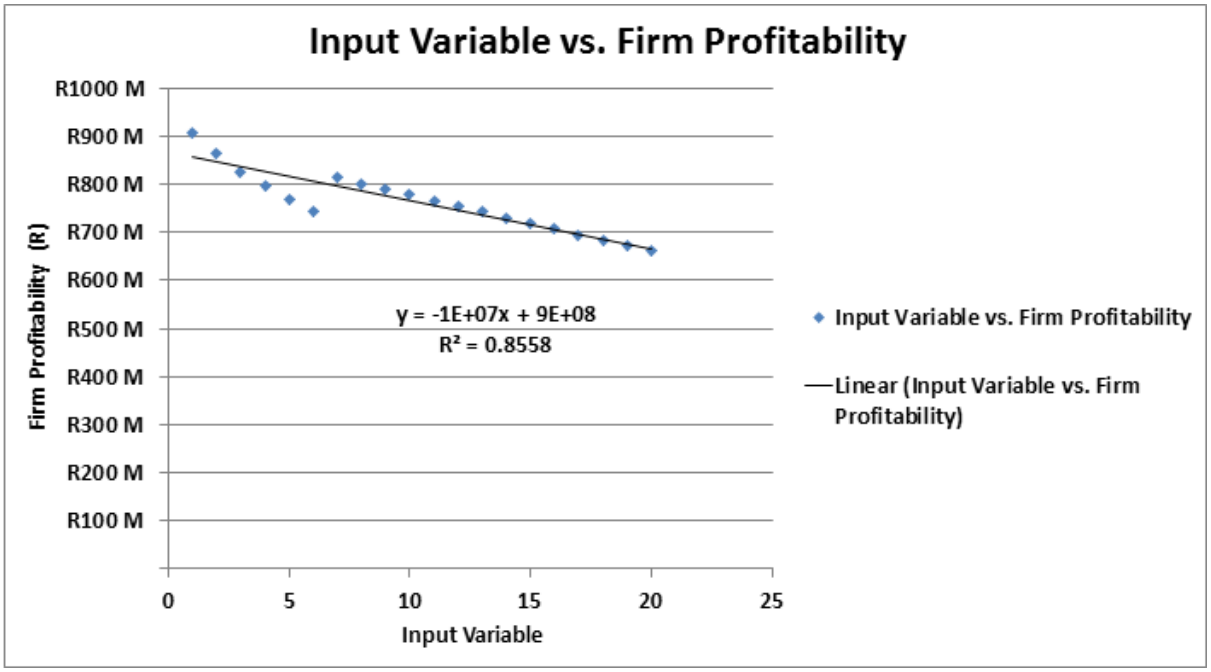

Figure 100: Input Variable vs. Firm Profitability

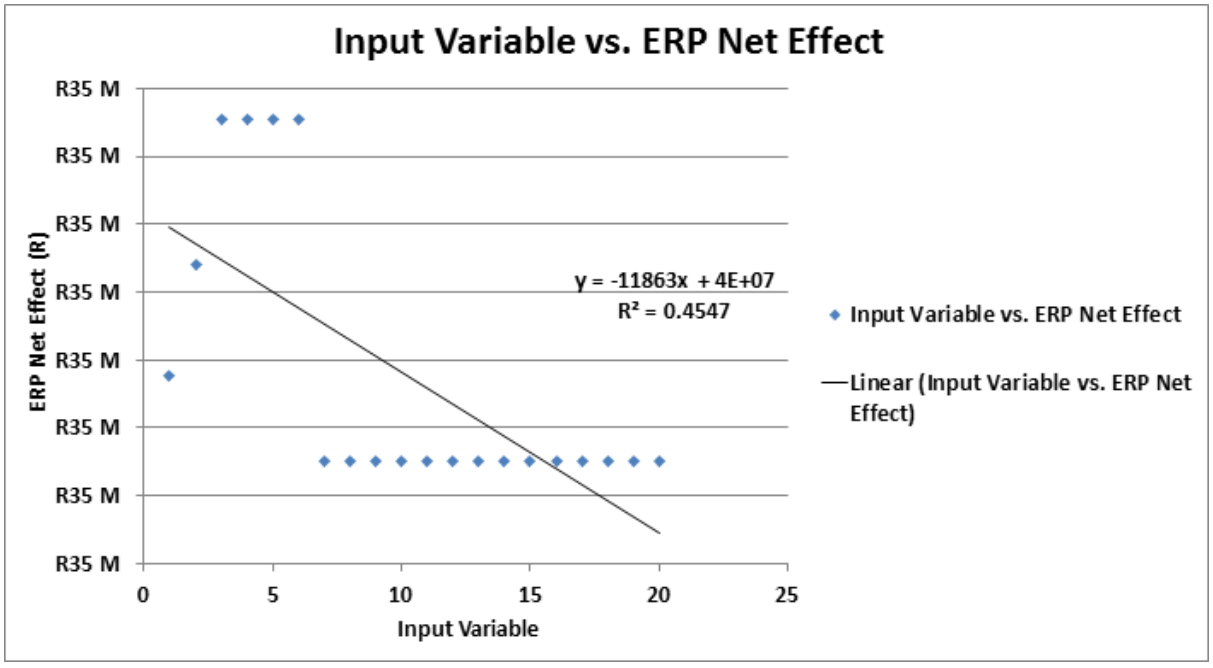

Figure 101: Input Variable vs. ERP Net Effect

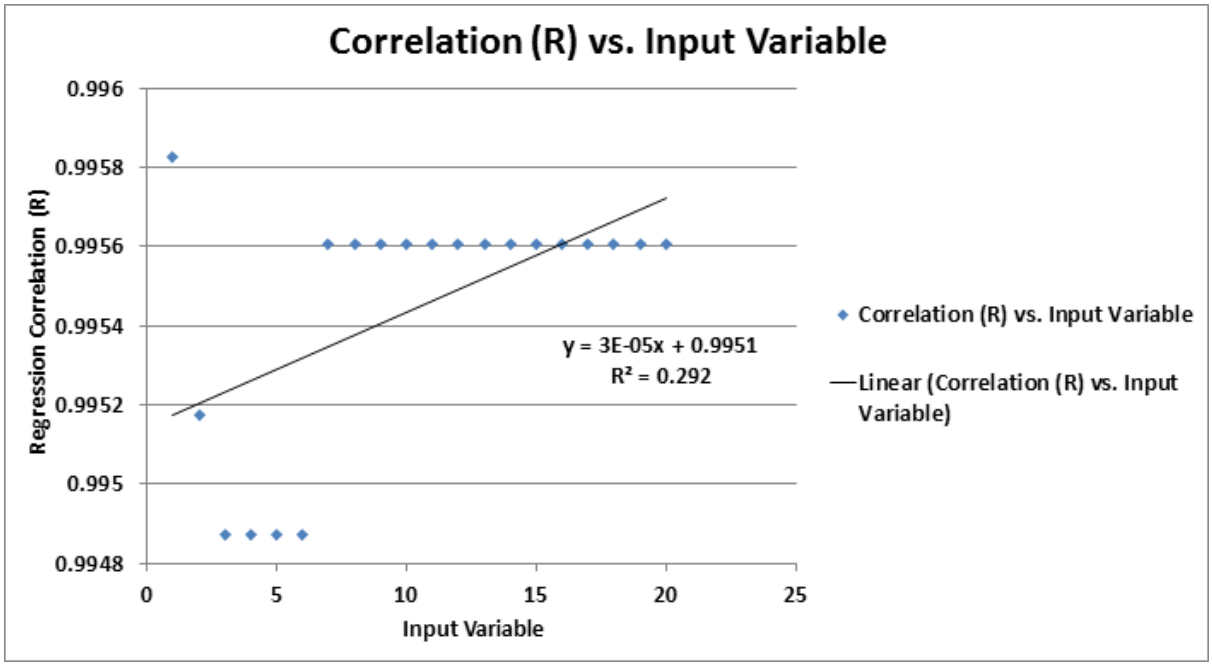

Figure 102: Correlation (R) vs. Input Variable

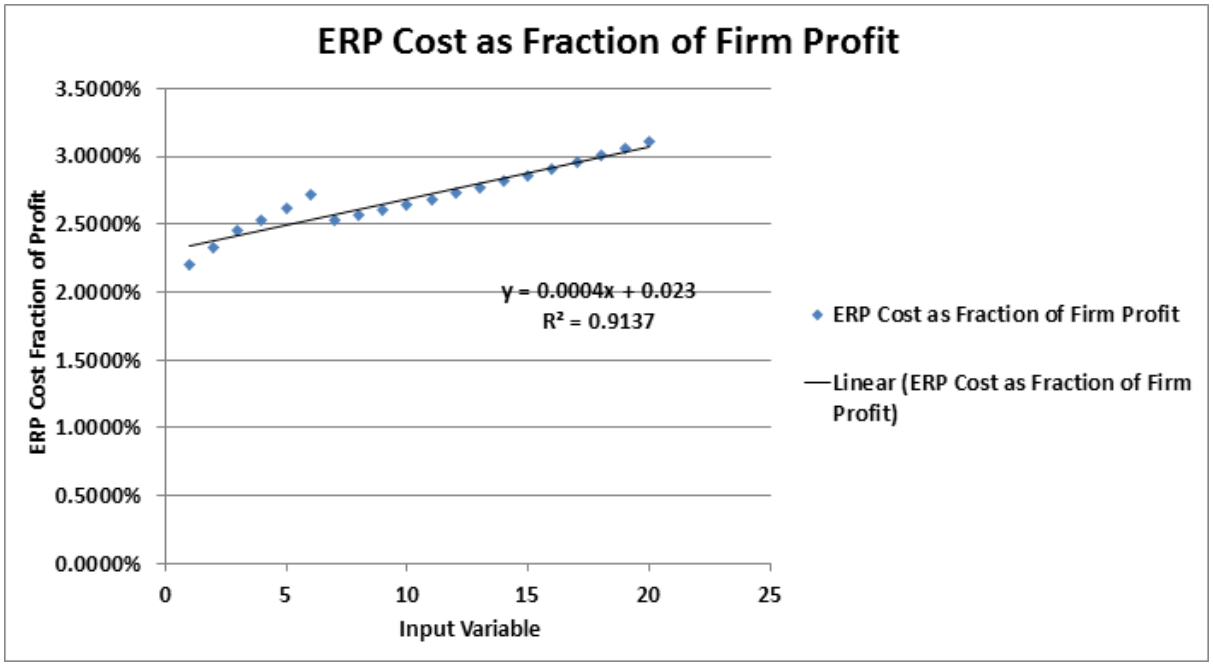

Figure 103: ERP Cost as Fraction of Firm Profit

8.1.1.5 Scnenario5: Base License Cost of ERP

8.1.1.5.1 Input Range and Step

Table 23: Scenario Input Range and Step Size

Range	0.1 to 10
Increment	0.3

The variable was stepped from 0.1 (a tenth of the actual base license cost), through to 10 (ten times the base license cost).

8.1.1.5.2 Results

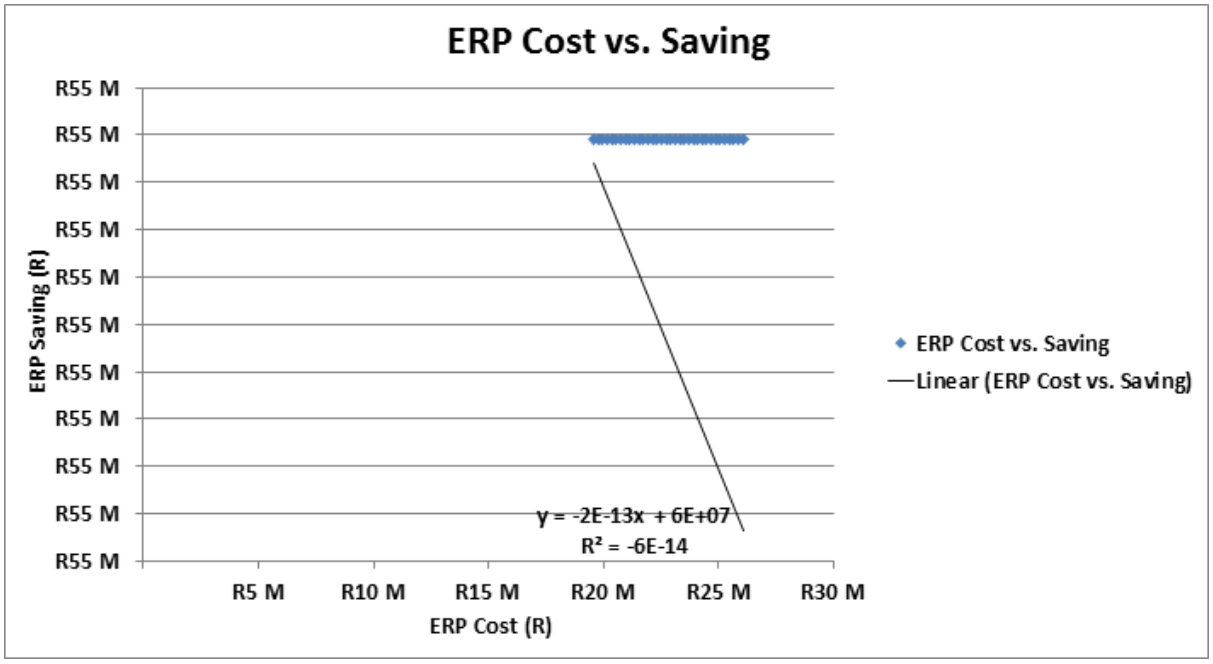

Figure 104: ERP Cost vs. Saving

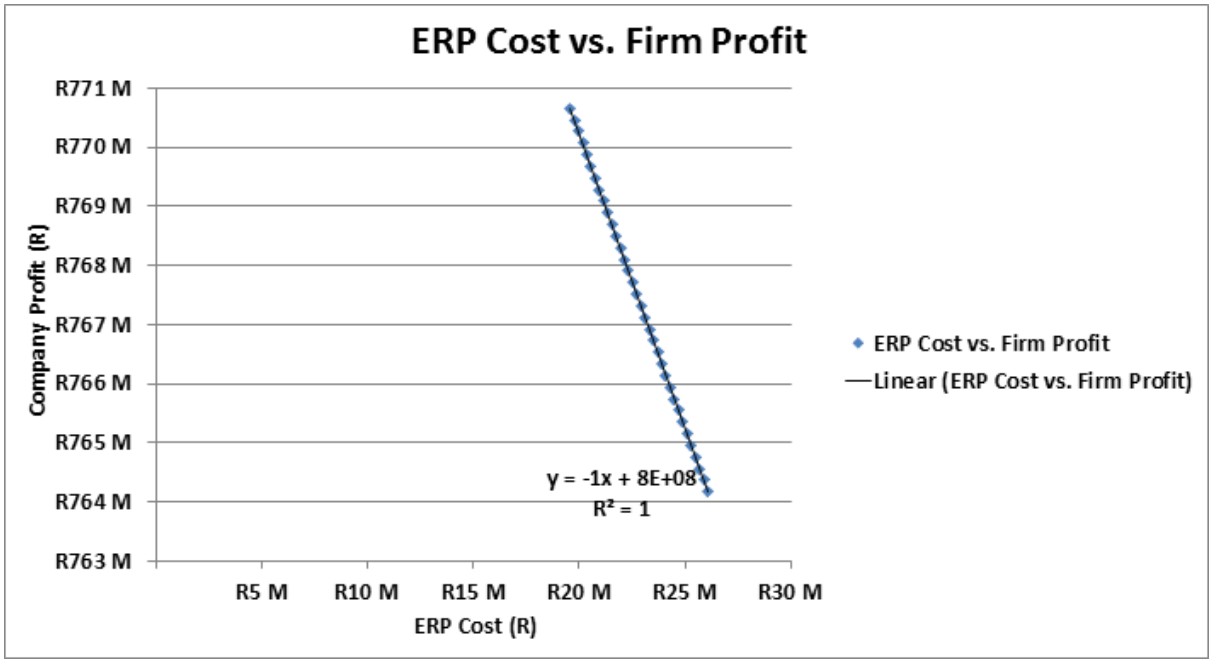

Figure 105: ERP Cost vs. Firm Profit

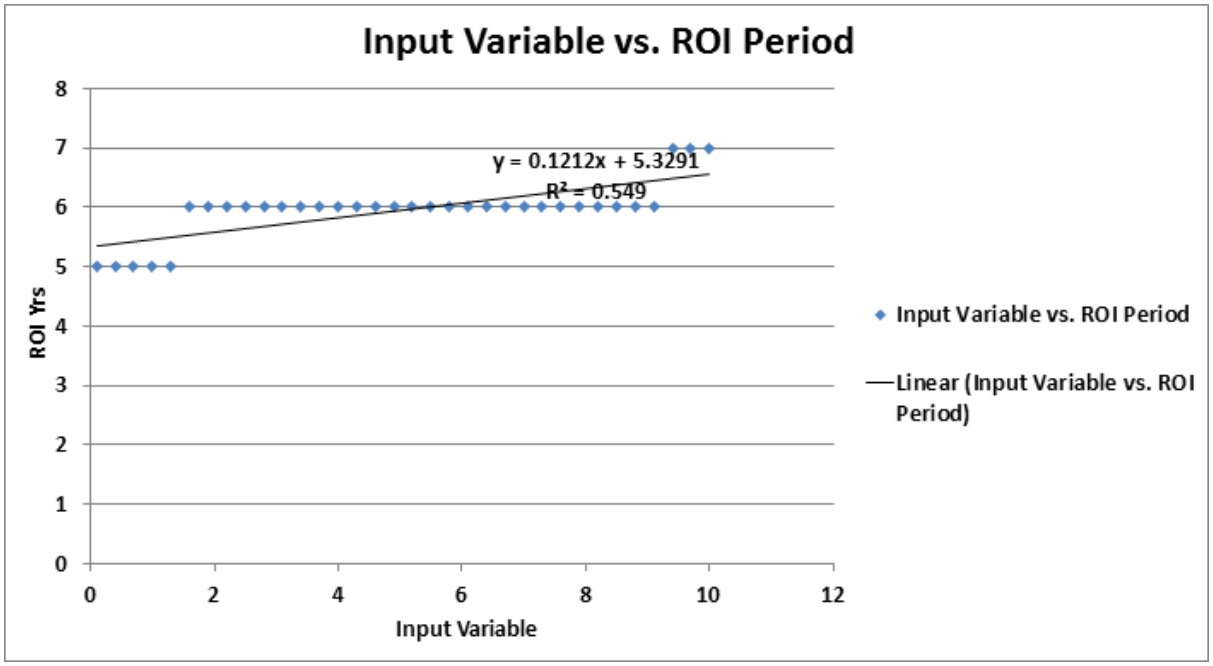

Figure 106: Input Variable vs. ROI Period

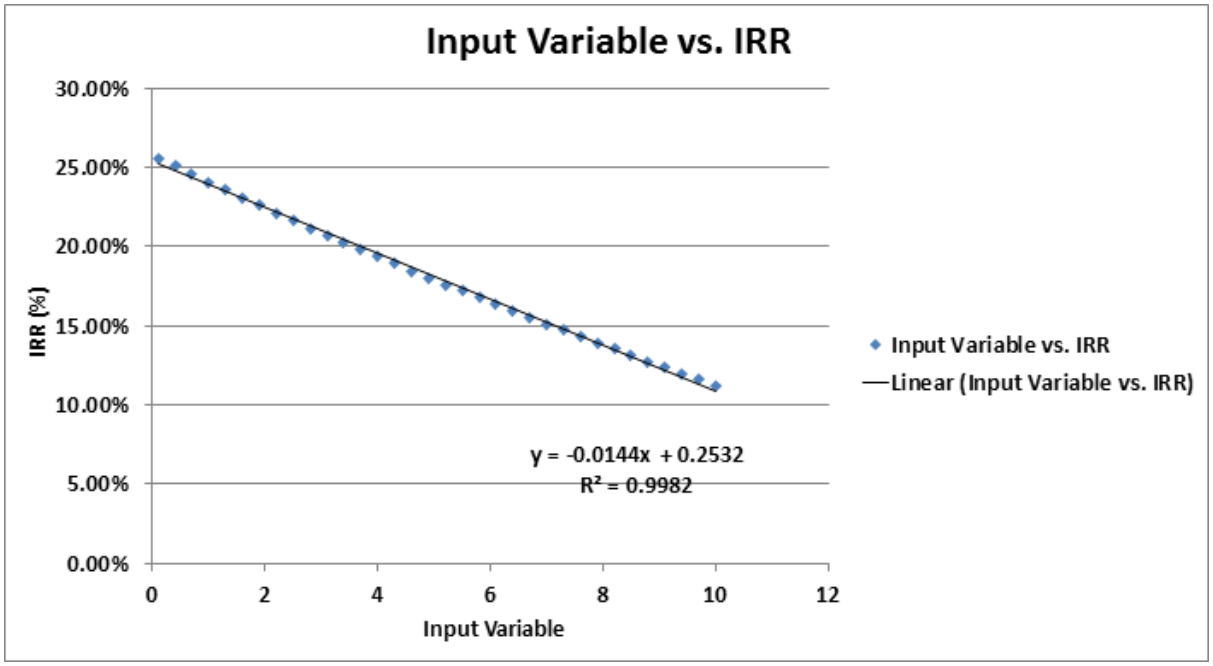

Figure 107: Input Variable vs. IRR

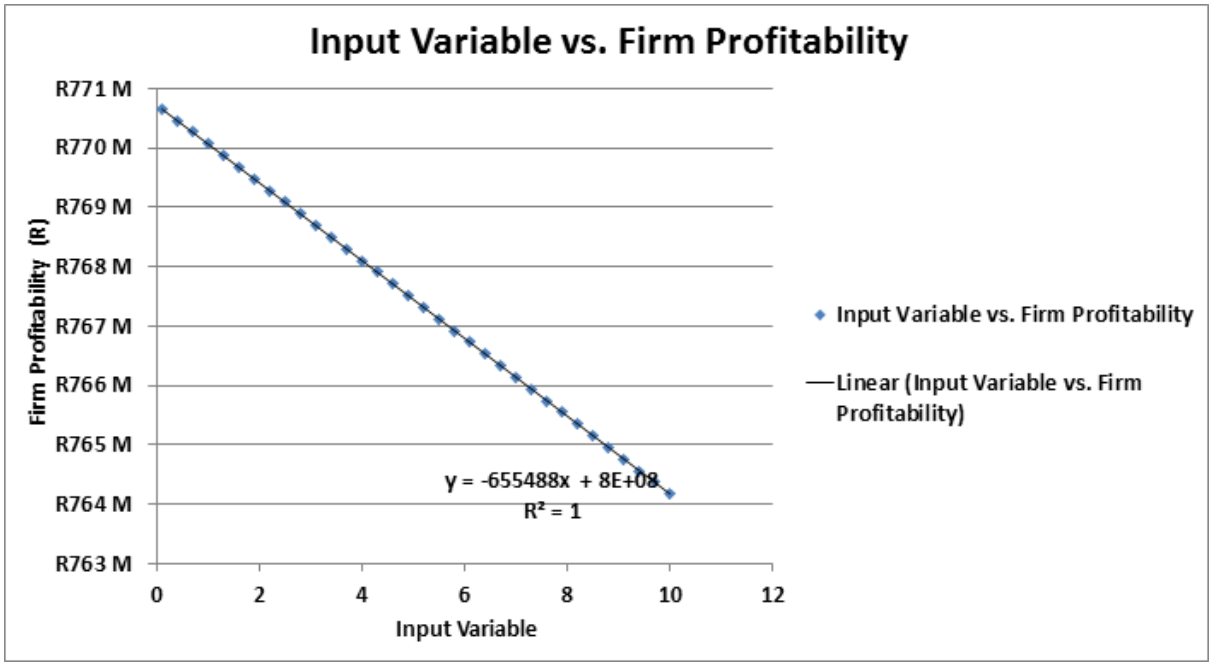

Figure 108: Input Variable vs. Firm Profitability

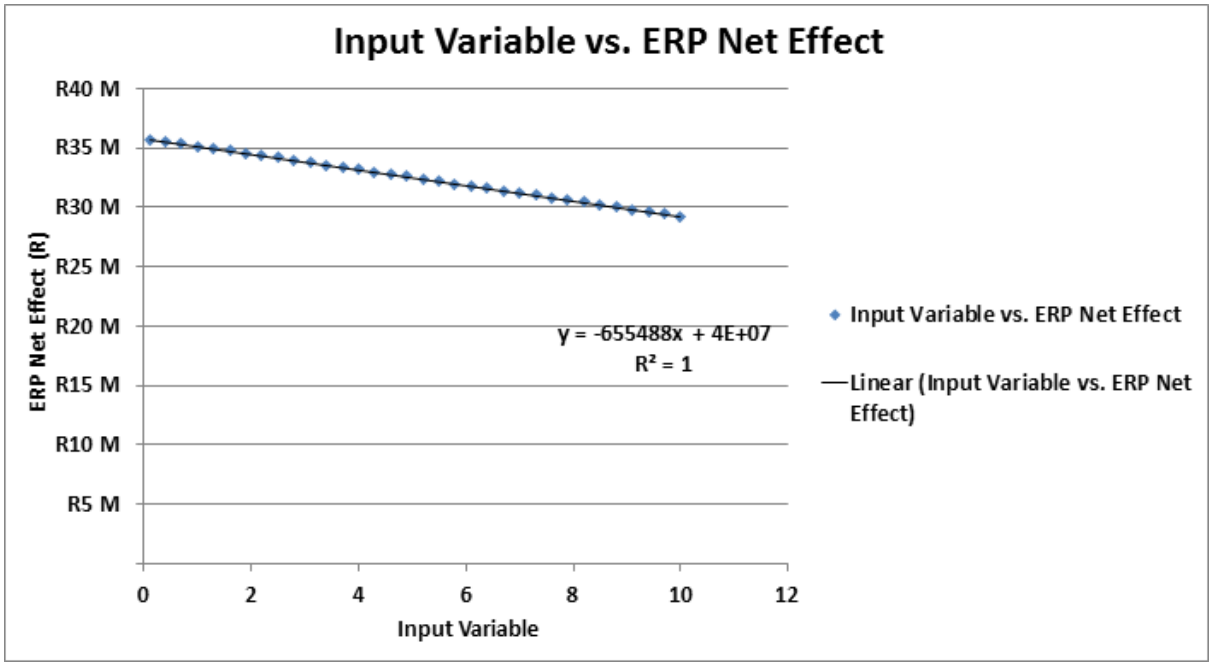

Figure 109: Input Variable vs. ERP Net Effect

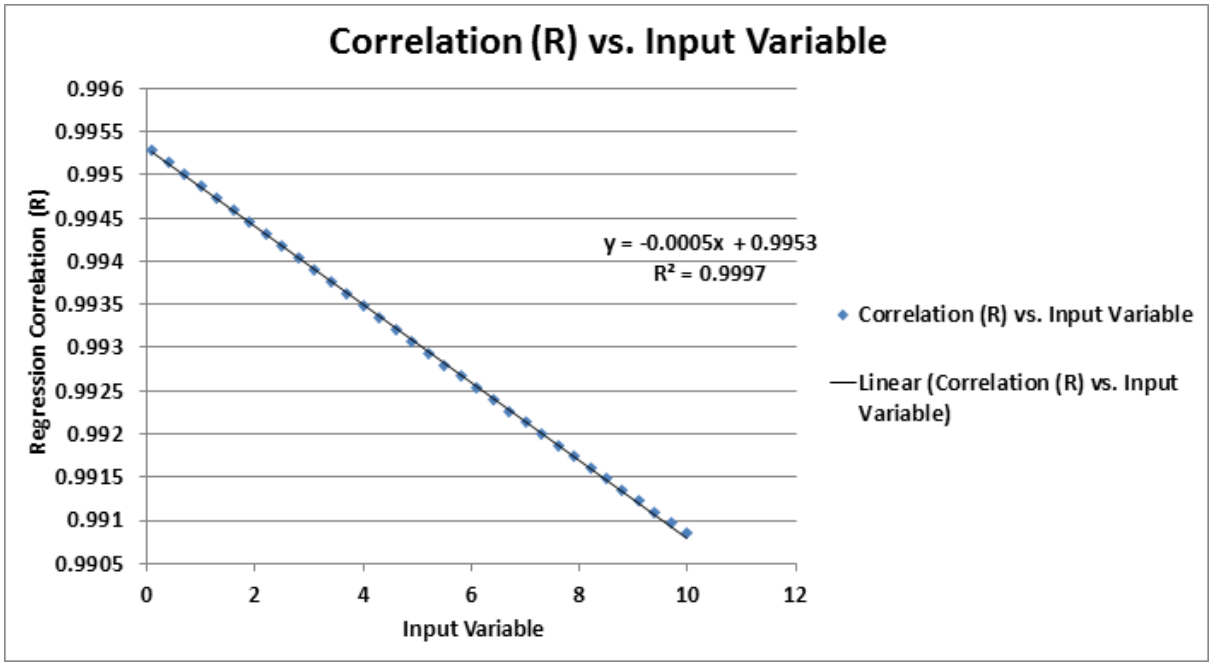

Figure 110: Correlation (R) vs. Input Variable

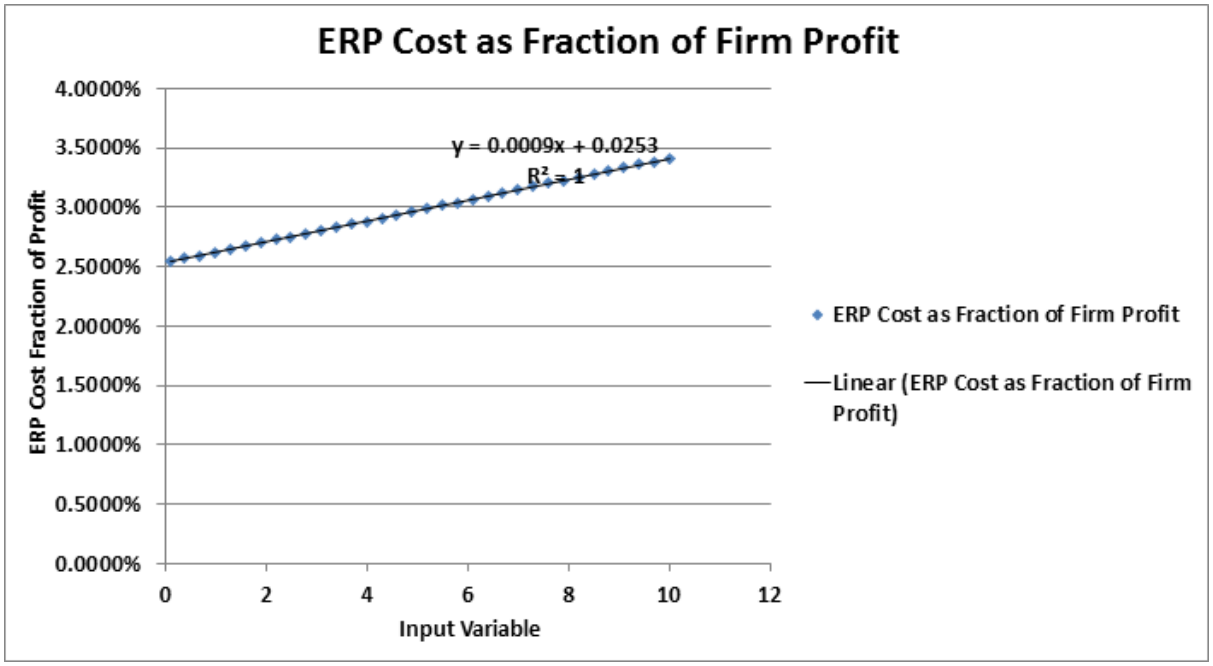

Figure 111: ERP Cost as Fraction of Firm Profit

8.1.1.6 Scnenario6: ERP Volume Spend License Fee

8.1.1.6.1 Input Range and Step

Table 24: Scenario Input Range and Step Size

Range	0.1 to 10
Increment	0.3

The variable was stepped from 0.1 to 10 in increments of 0.3.

This means that the initial step is a tenth of the actual spend volume cost and the final step is ten times as much as the actual volume spend.

8.1.1.6.2 Results

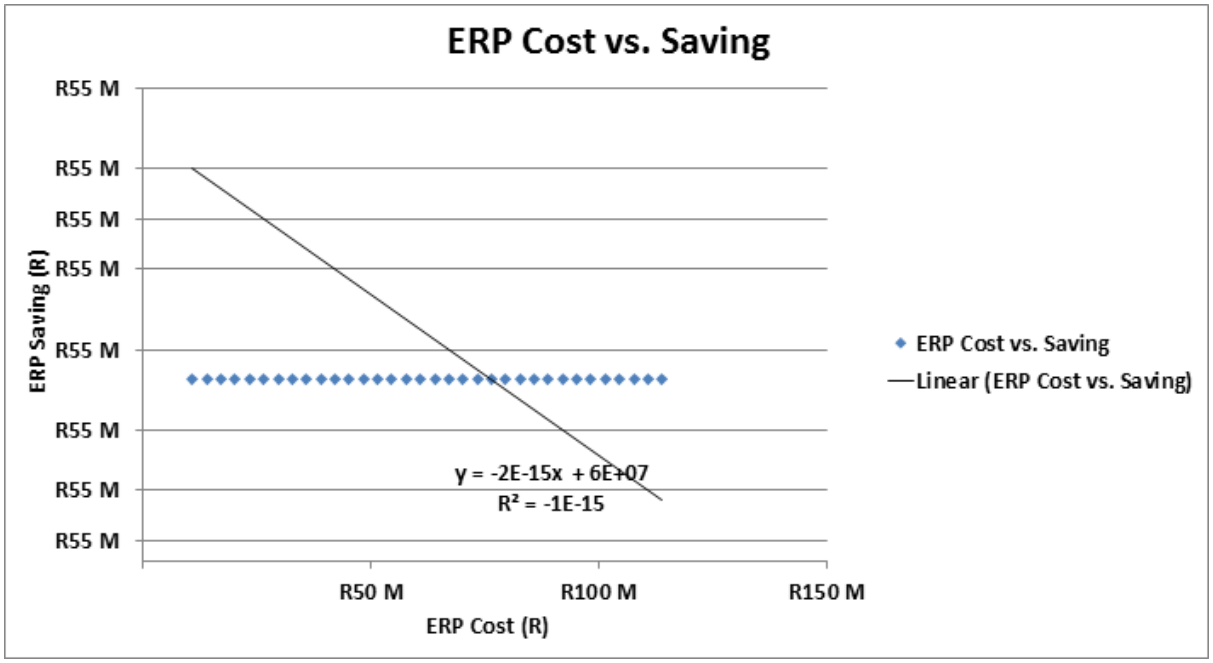

Figure 112: ERP Cost vs. Saving

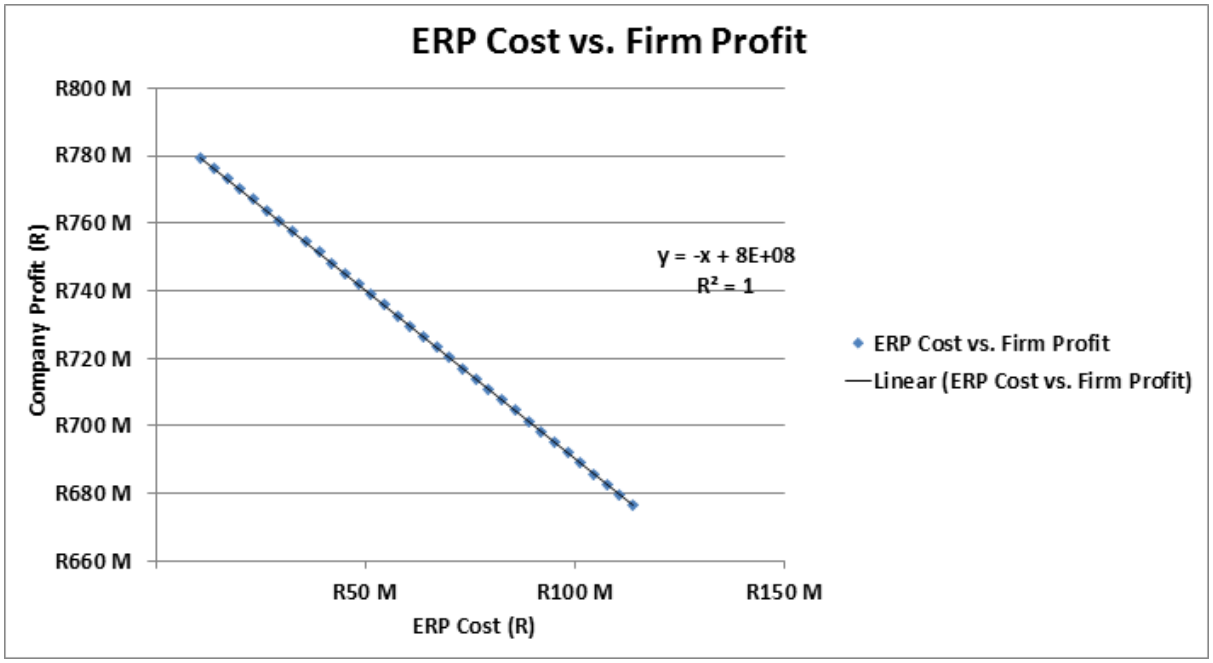

Figure 113: ERP Cost vs. Firm Profit

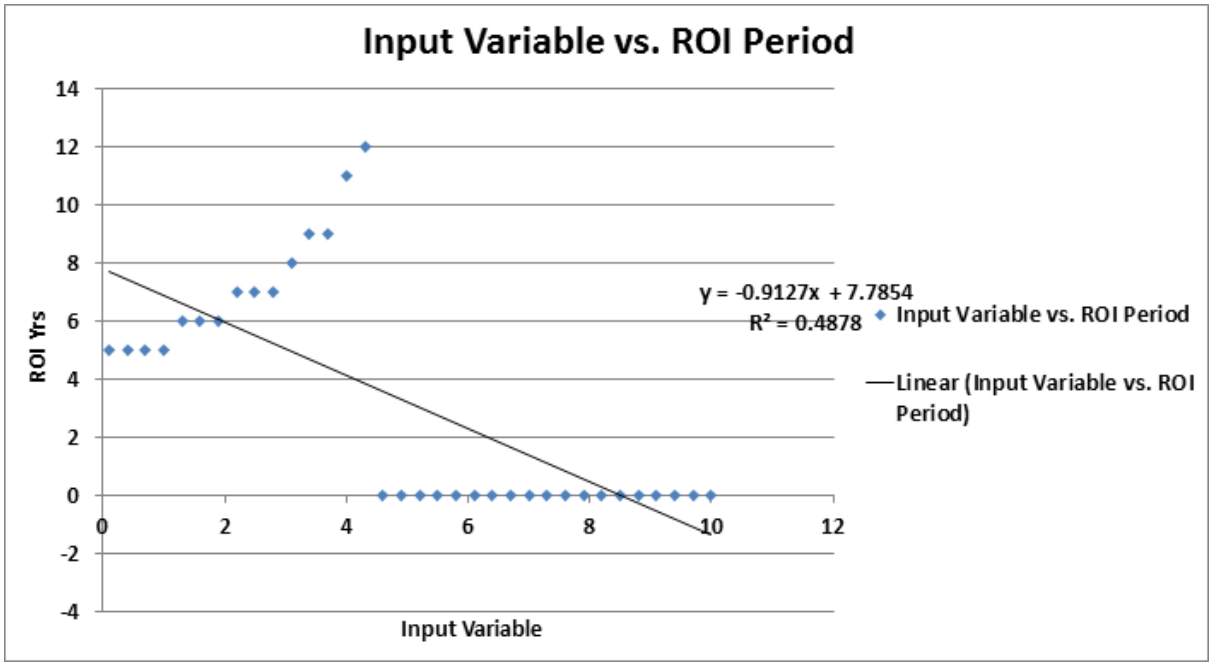

Figure 114: Input Variable vs. ROI Period

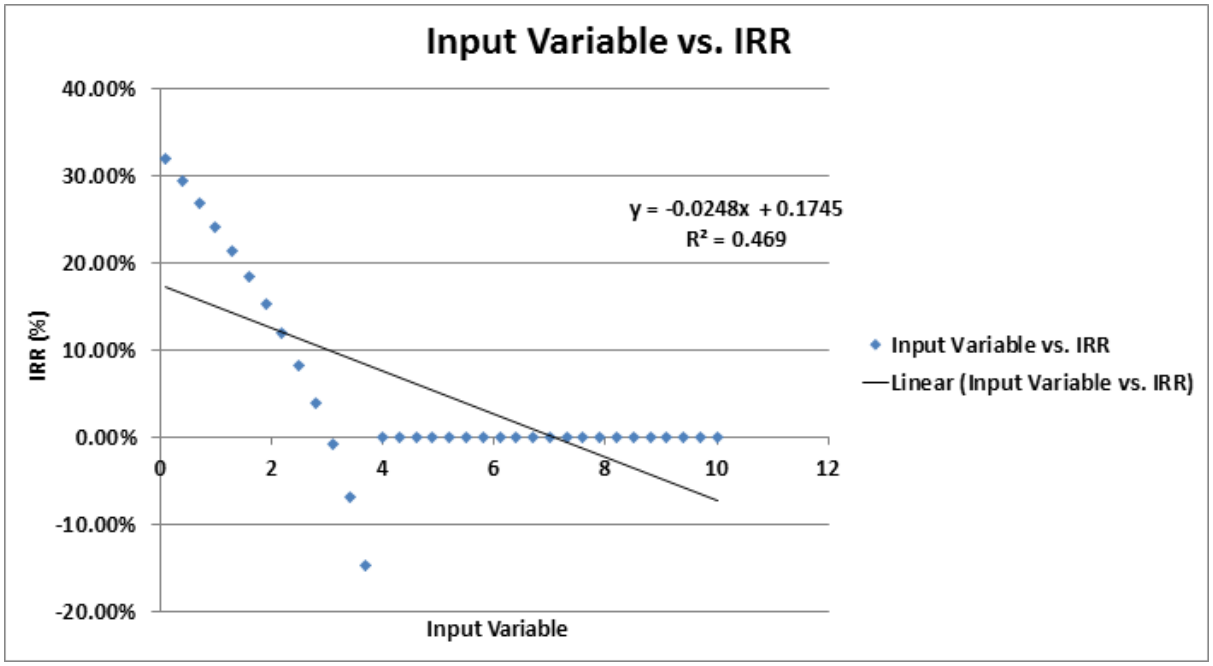

Figure 115: Input Variable vs. IRR

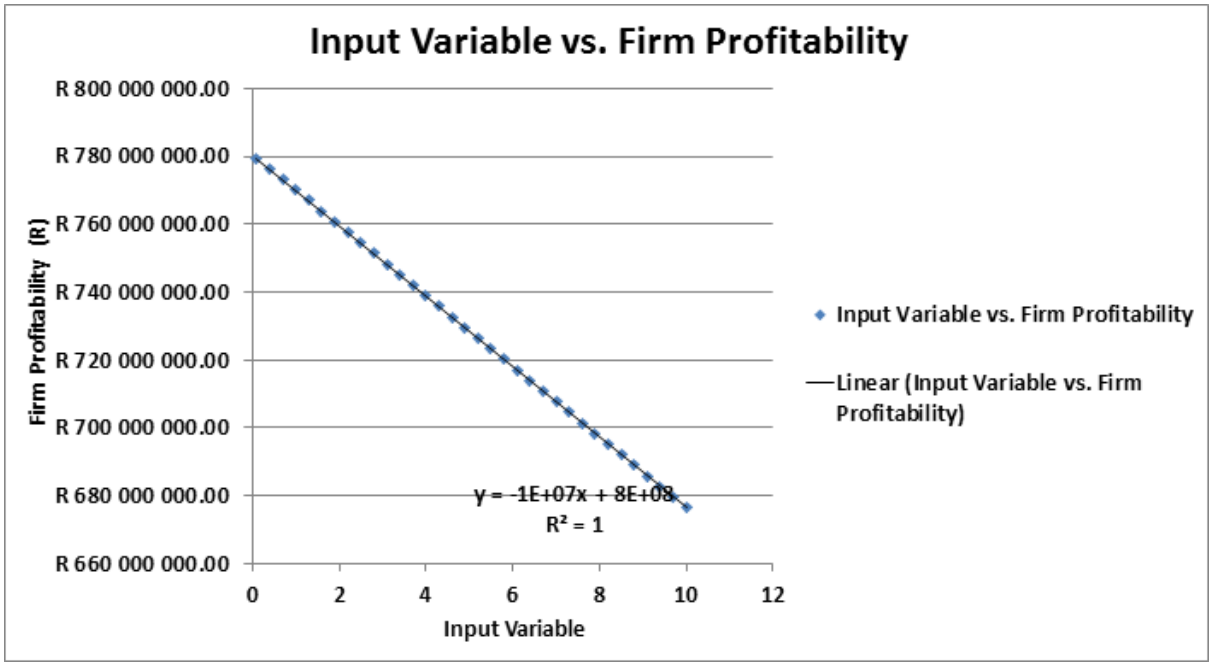

Figure 116: Input Variable vs. Firm Profitability

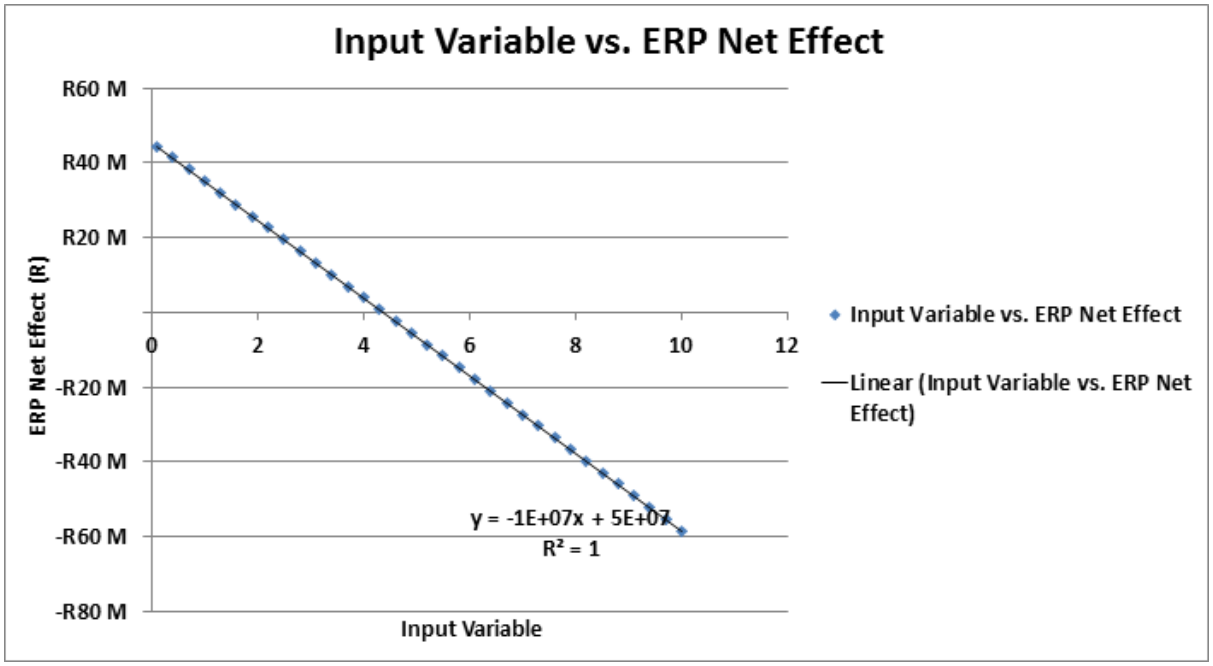

Figure 117: Input Variable vs. ERP Net Effect

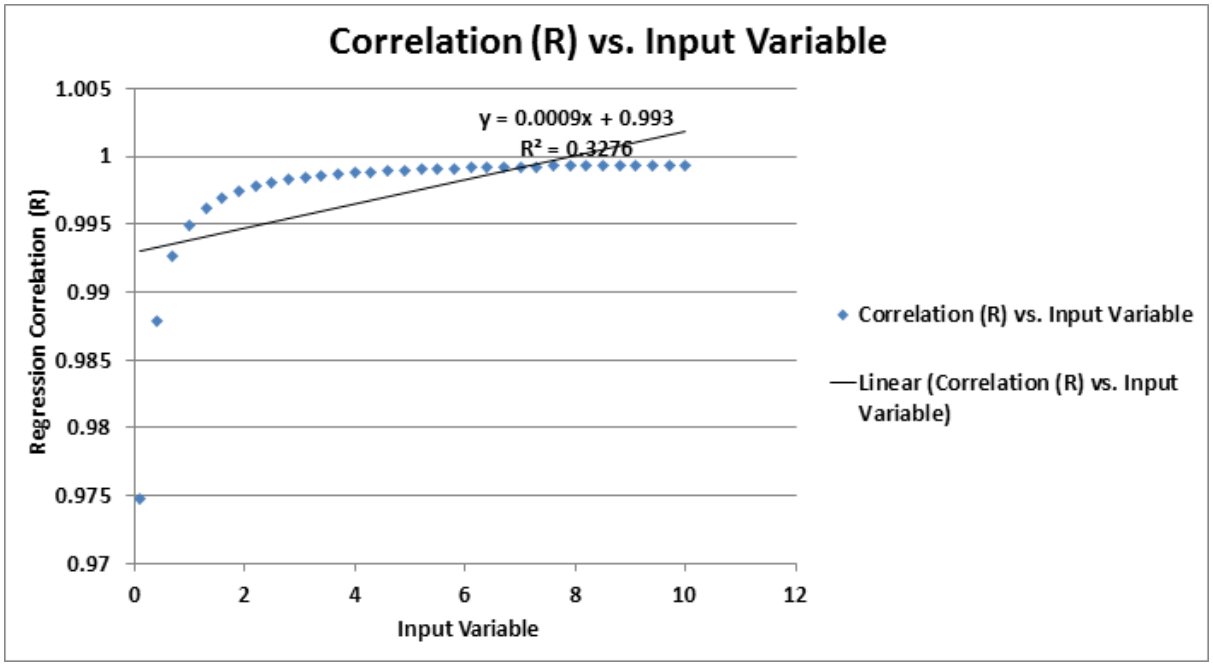

Figure 118: Correlation (R) vs. Input Variable

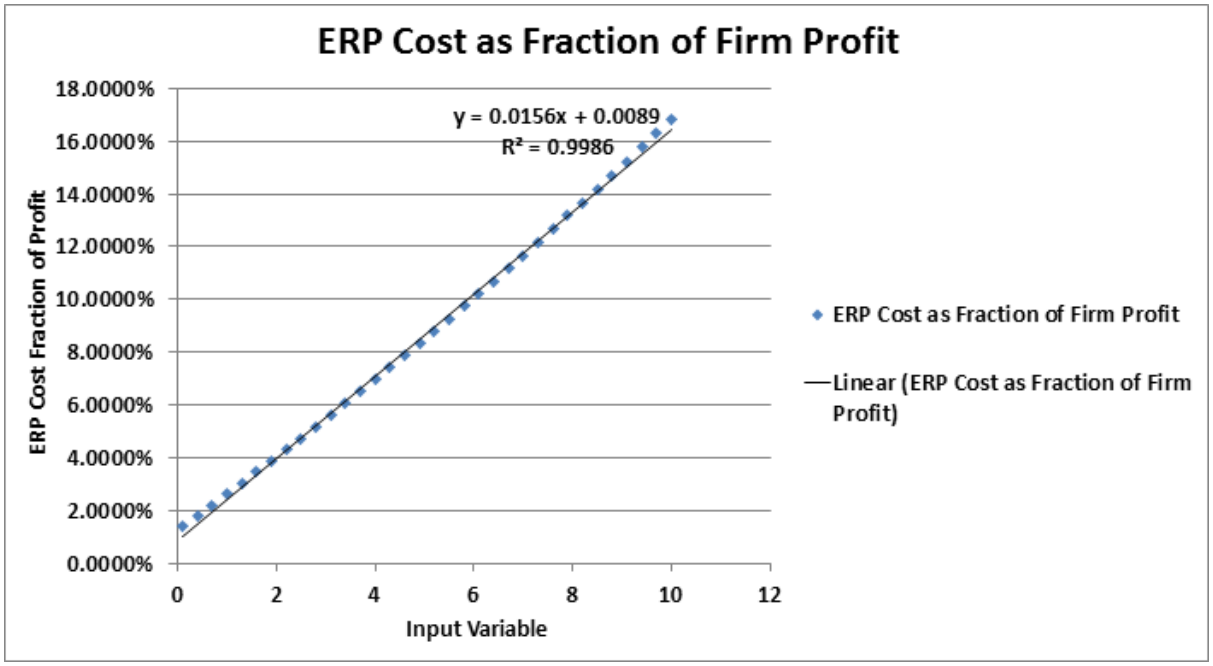

Figure 119: ERP Cost as Fraction of Firm Profit

8.1.1.7 Scnenario7: Maintenance Cost

8.1.1.7.1 Input Range and Step

Table 25: Scenario Input Range and Step Size

Range	0.001 to 0.1

Increment	0.002

8.1.1.7.2 Results

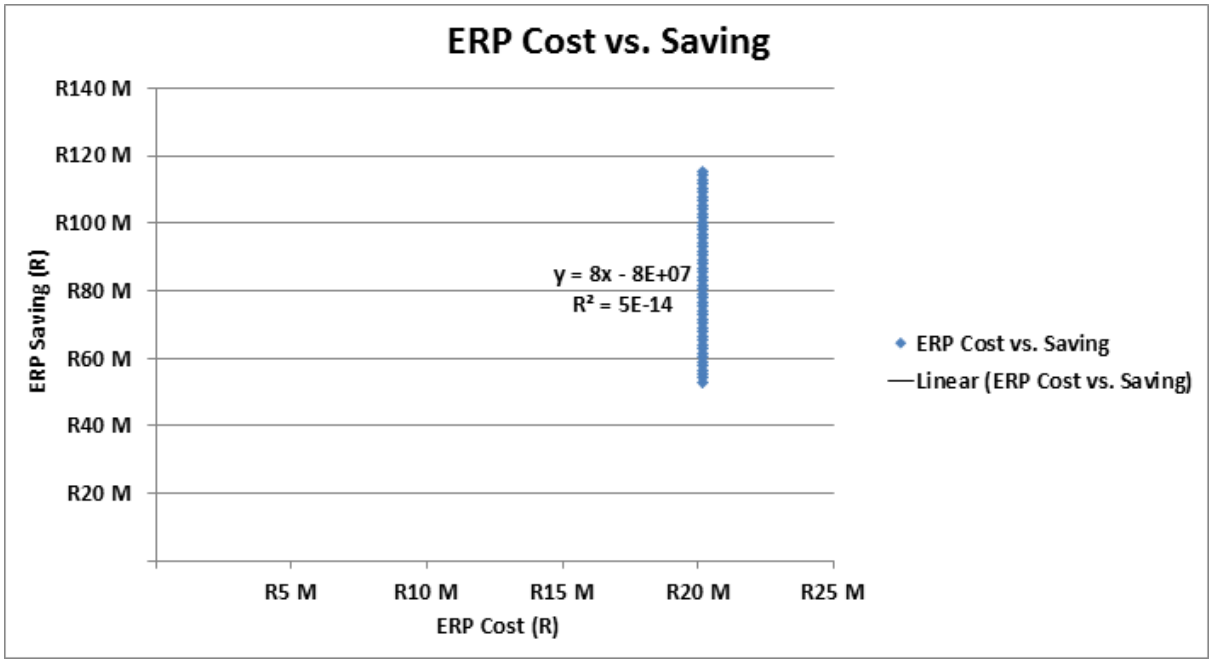

Figure 120: ERP Cost vs. Saving

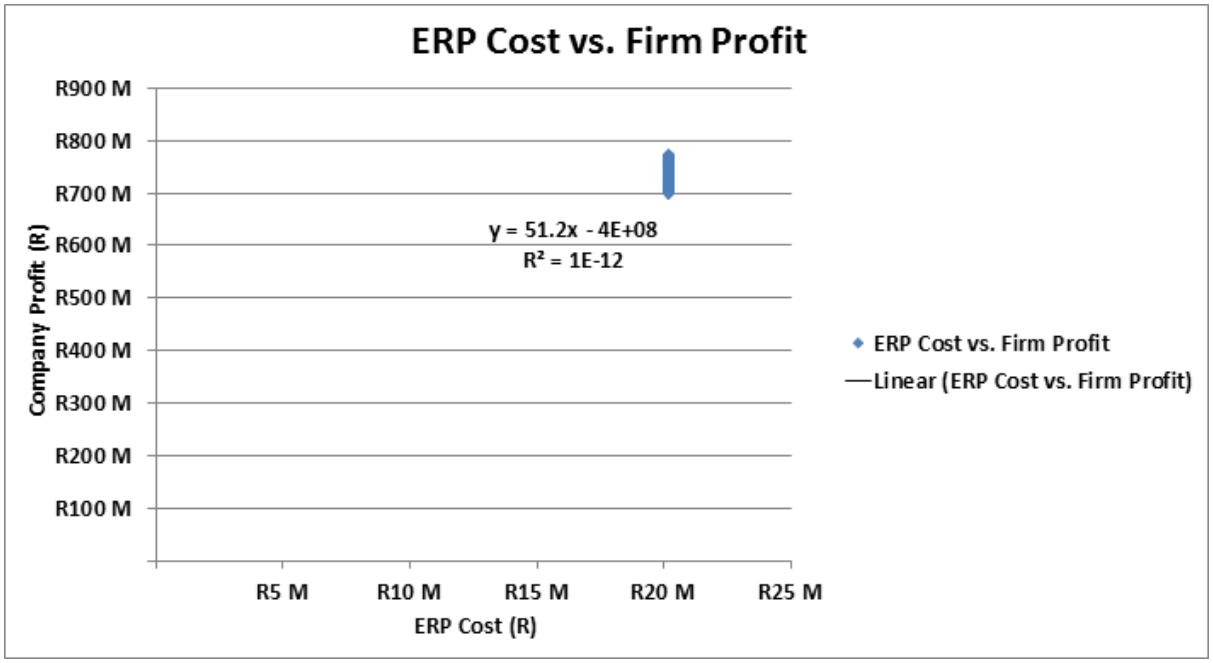

Figure 121: ERP Cost vs. Firm Profit

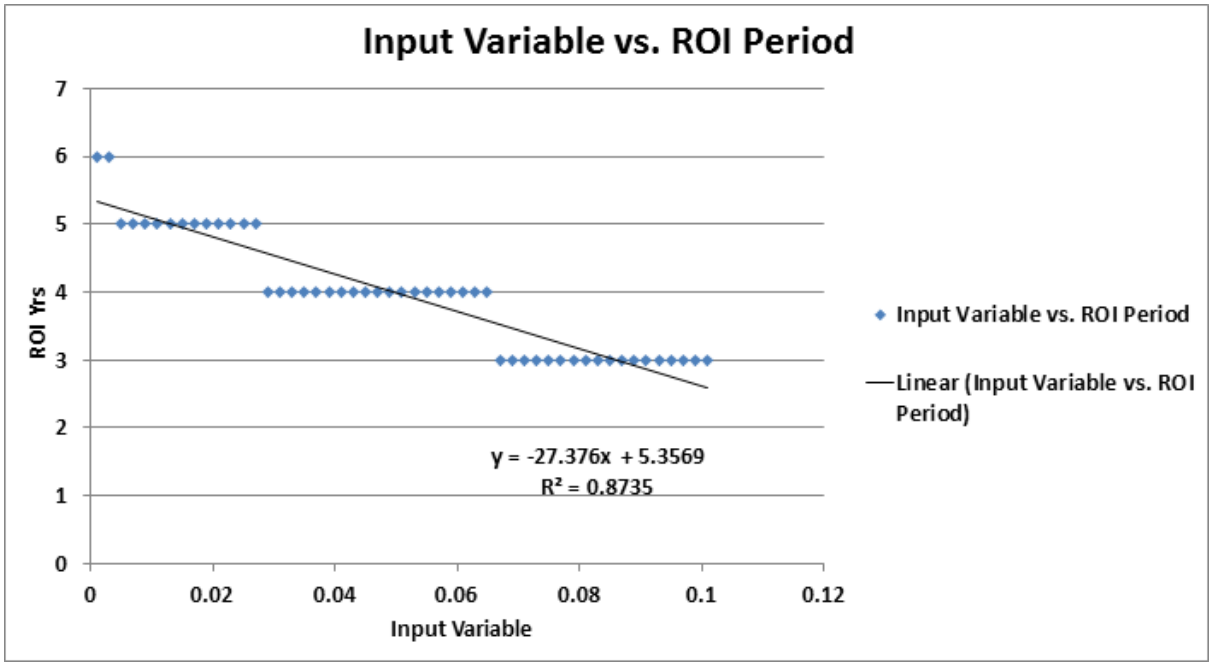

Figure 122: Input Variable vs. ROI Period

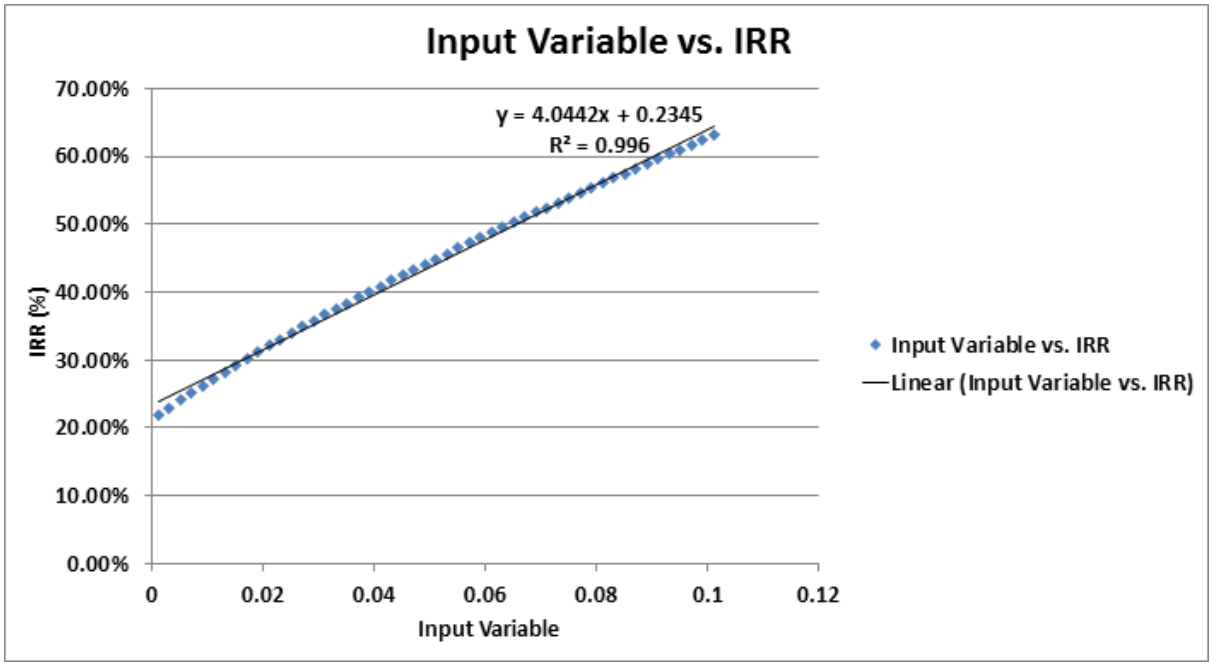

Figure 123: Input Variable vs. IRR

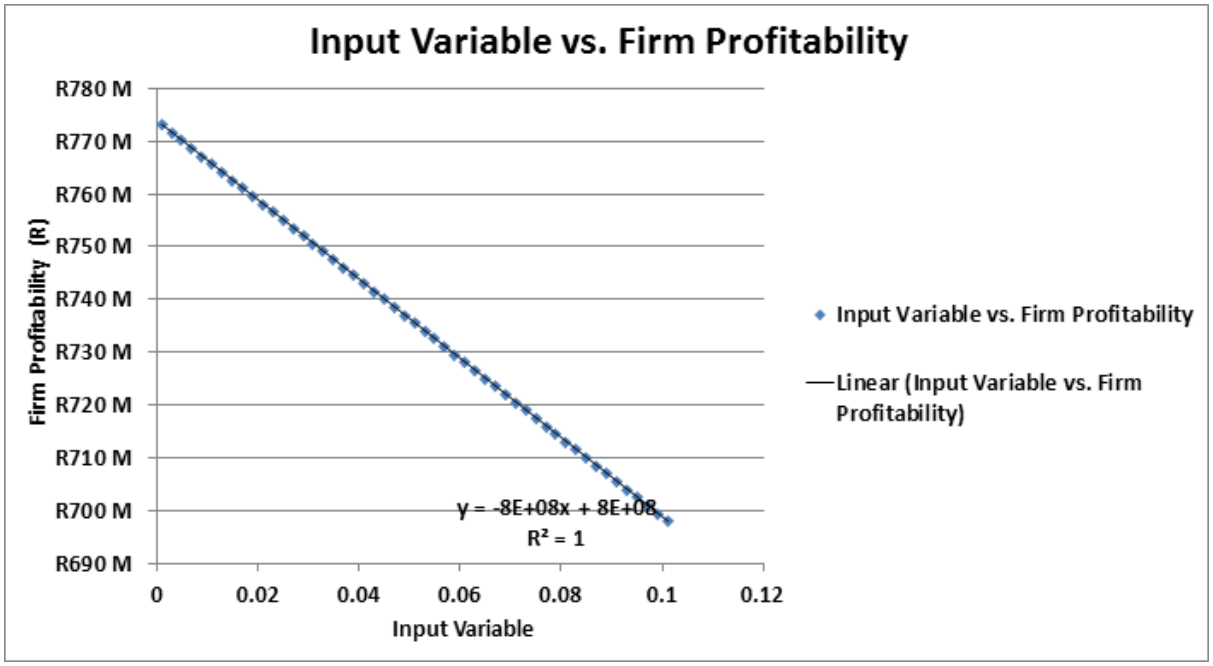

Figure 124: Input Variable vs. Firm Profitability

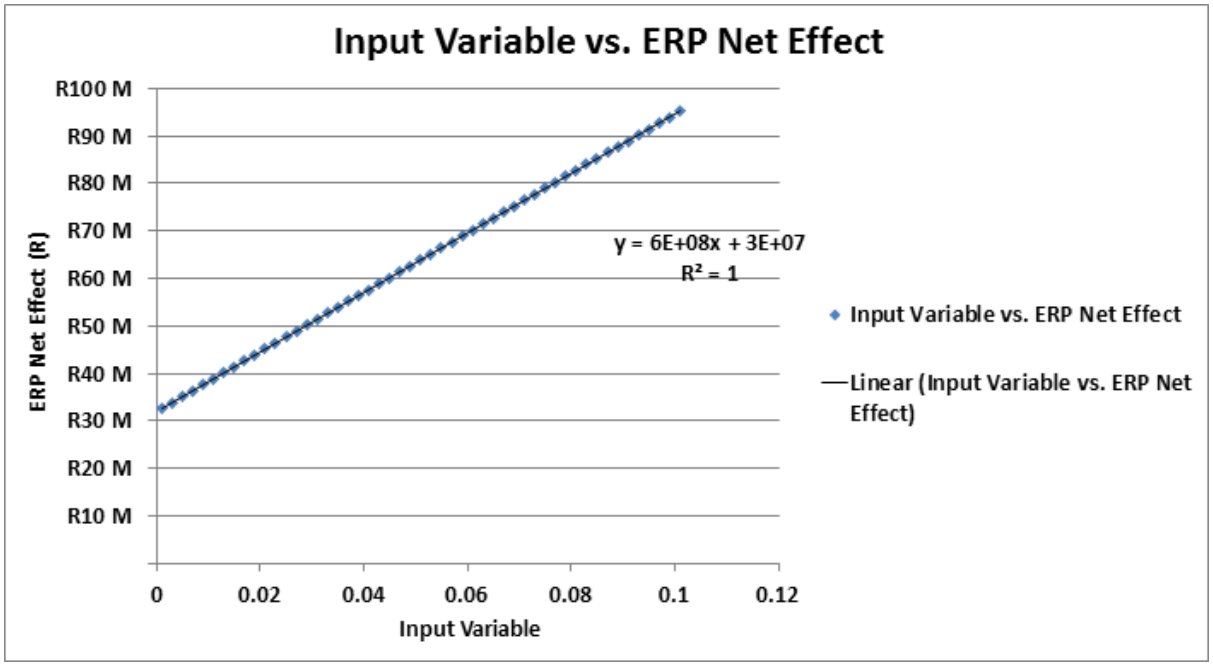

Figure 125: Input Variable vs. ERP Net Effect

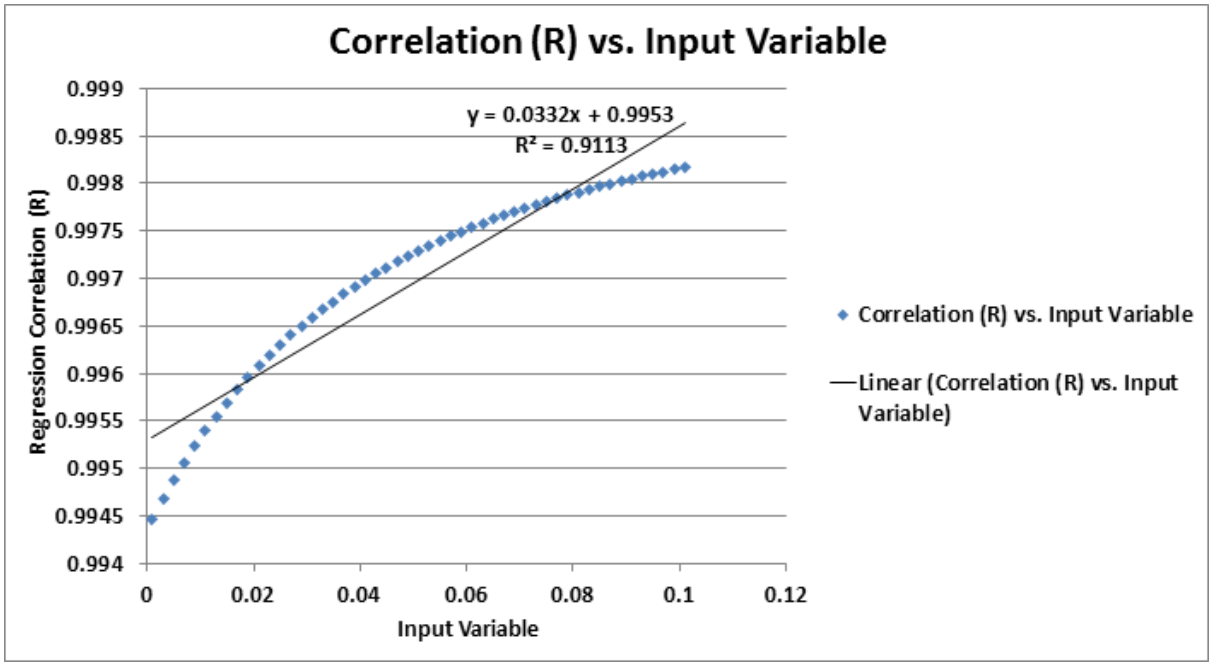

Figure 126: Correlation (R) vs. Input Variable

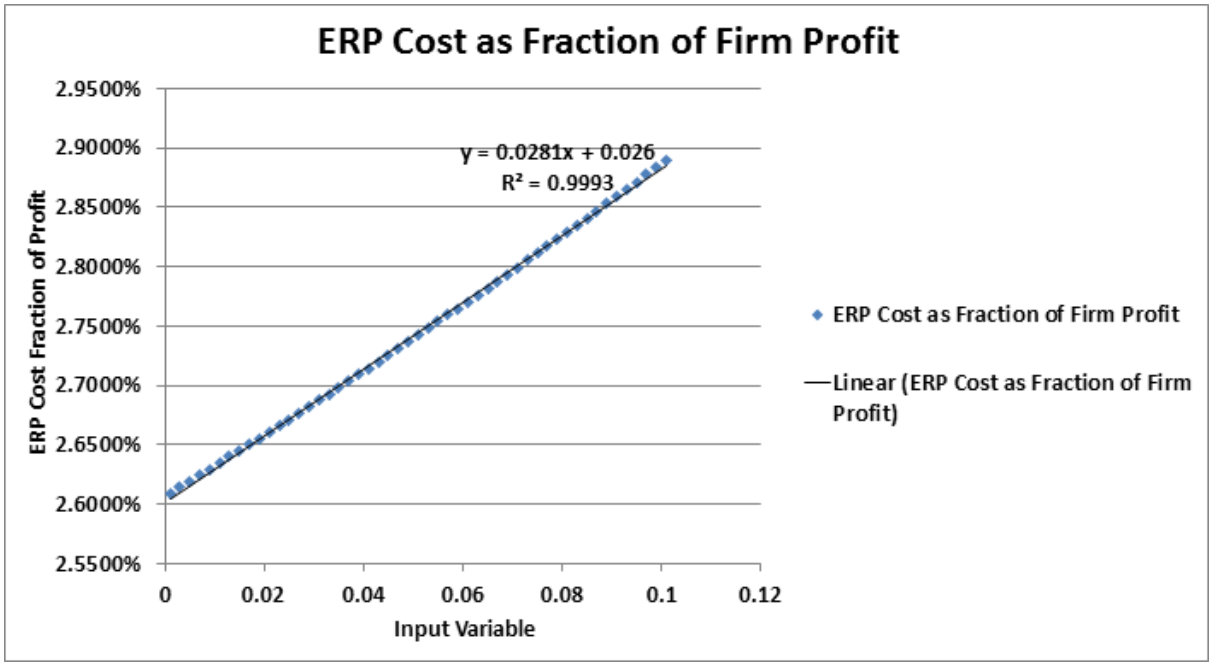

Figure 127: ERP Cost as Fraction of Firm Profit

8.1.1.8 Scenario 8: User License Cost

8.1.1.8.1 Input Range and Step

Table 26: Scenario Input Range and Step Size

Range	0.1 to 10
Increment	0.3

The variable was stepped from 0.1 (a tenth of the actual user license fees) to 10 (ten times the actual user license fee) in increments of 0.3.

8.1.1.8.2 Results

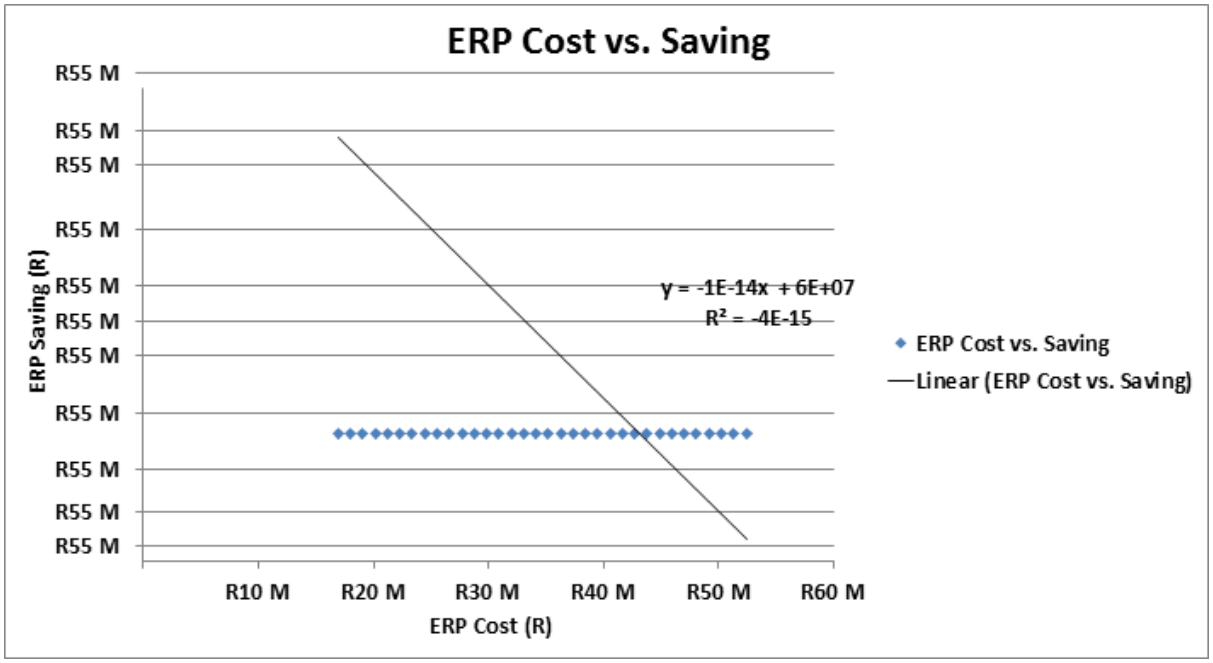

Figure 128: ERP Cost vs. Saving

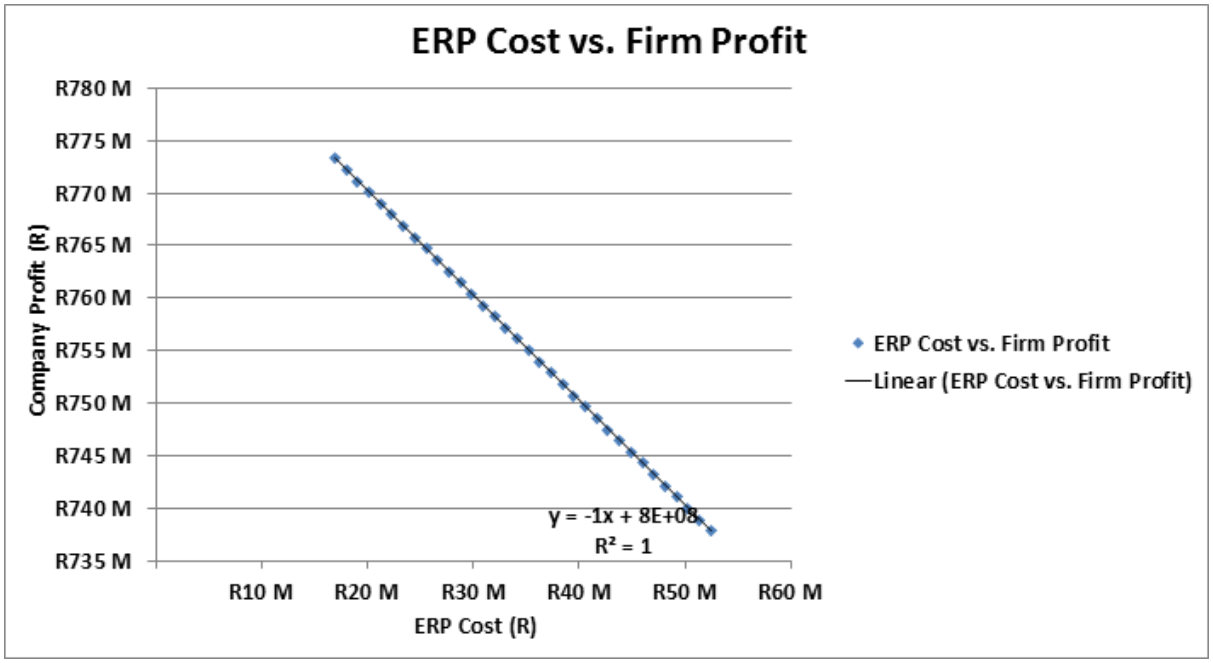

Figure 129: ERP Cost vs. Firm Profit

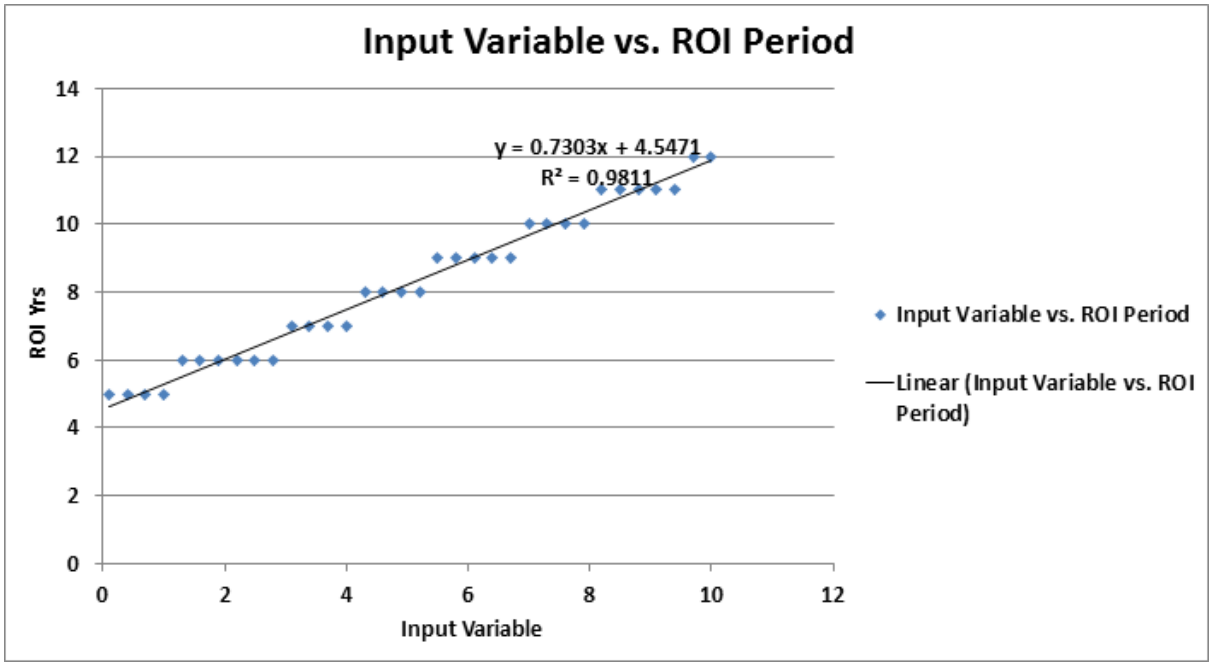

Figure 130: Input Variable vs. ROI Period

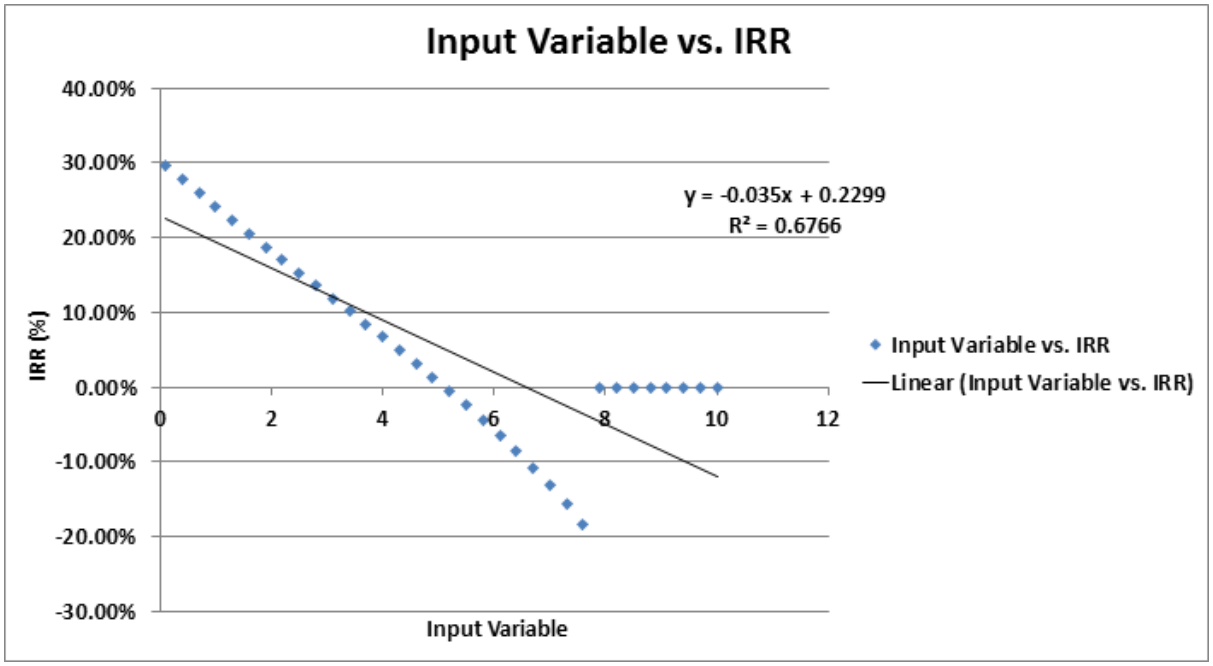

Figure 131: Input Variable vs. IRR

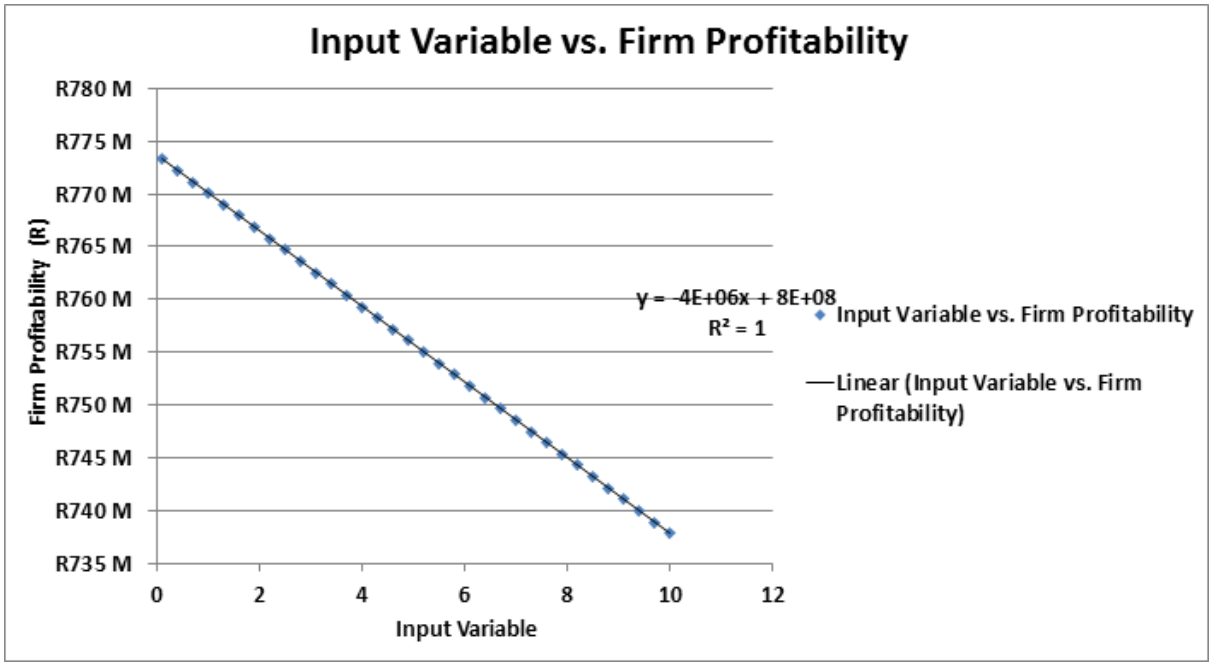

Figure 132: Input Variable vs. Firm Profitability

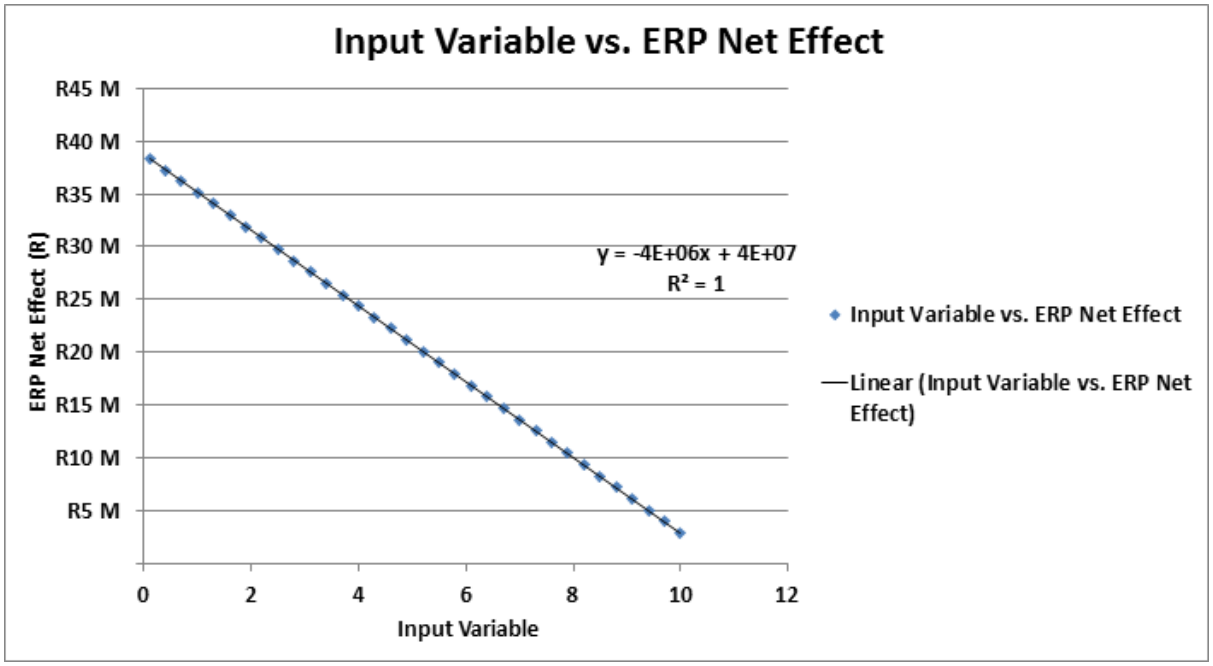

Figure 133: Input Variable vs. ERP Net Effect

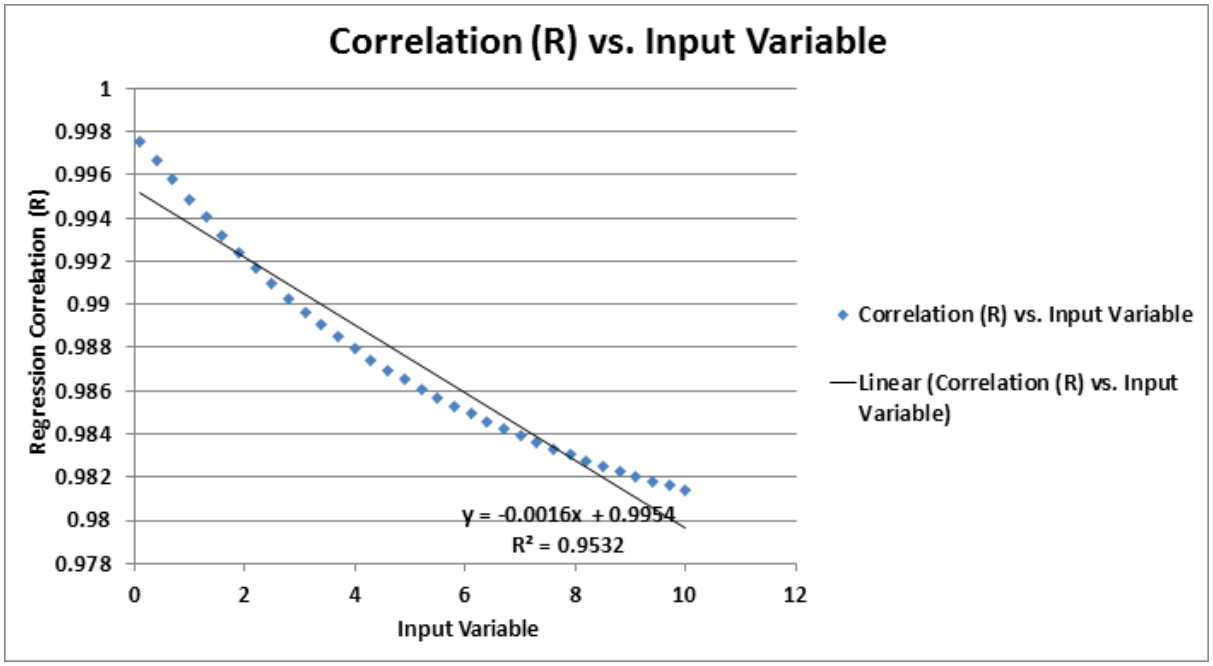

Figure 134: Correlation (R) vs. Input Variable

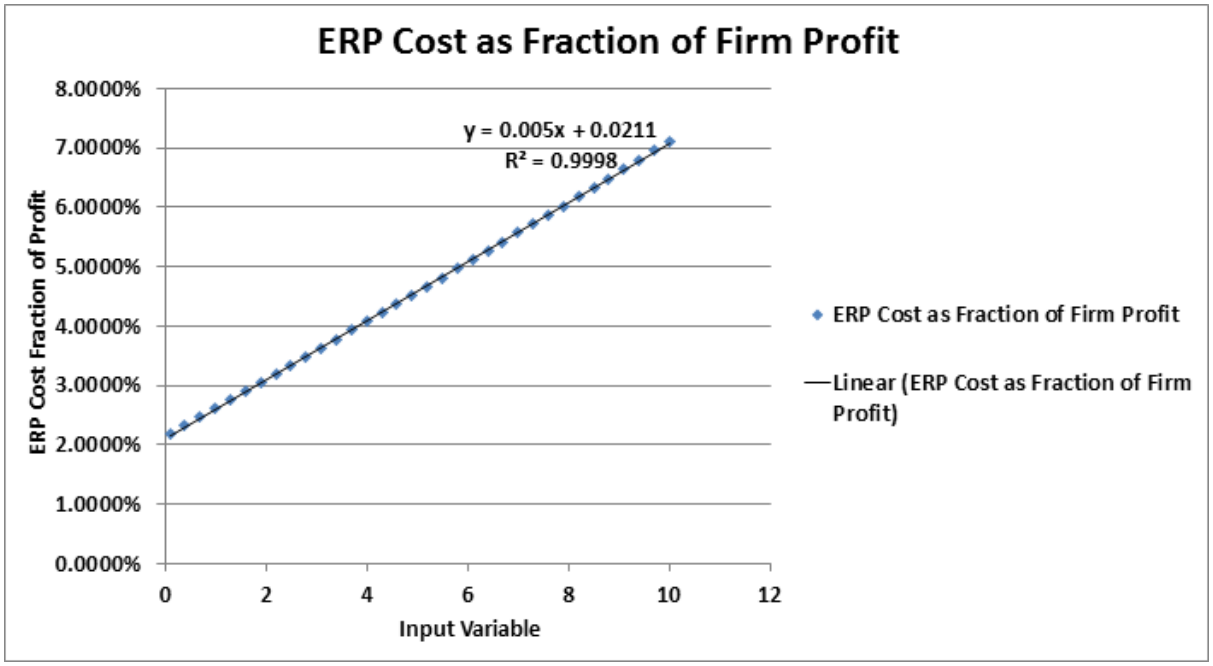

Figure 135: ERP Cost as Fraction of Firm Profit

8.1.1.9 Scenario 9: Competitiveness Bonus

8.1.1.9.1 Input Range and Step

Table 27: Scenario Input Range and Step Size

Range	0.1 to 10

Increment	0.3

The variable is stepped from 0.1 to 10 in increments of 0.3. In other words, the company would realise 100.1% through to 110% of their actual profit over the range of the input variable.

8.1.1.9.2 Results

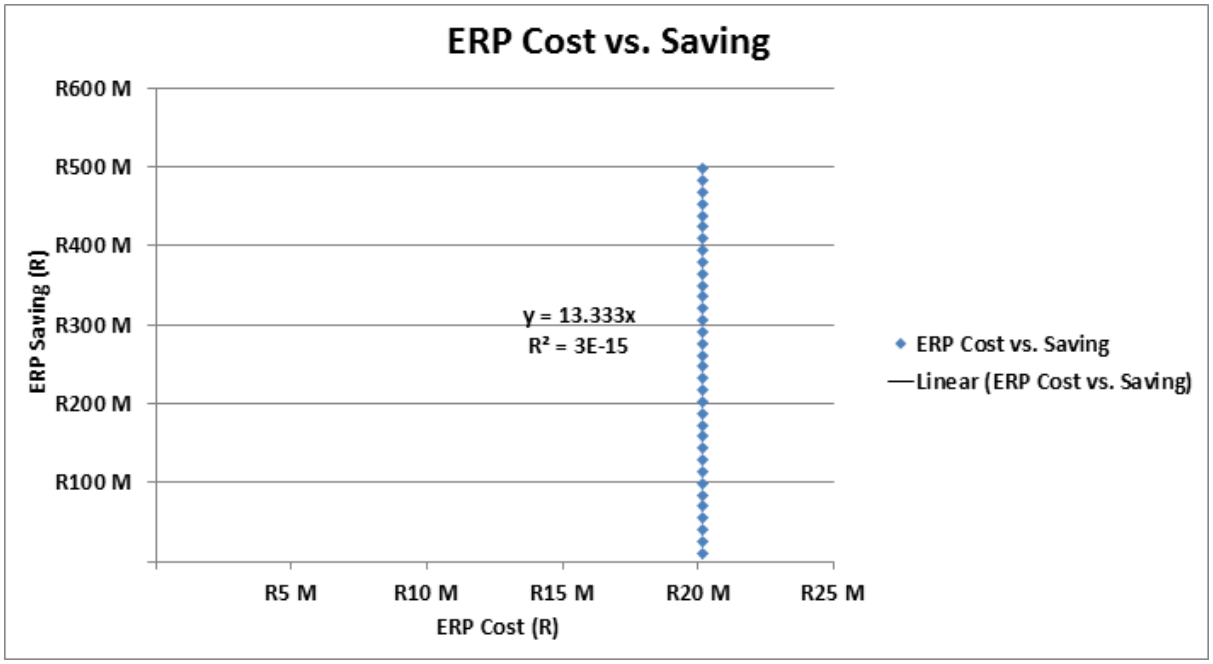

Figure 136: ERP Cost vs. Saving

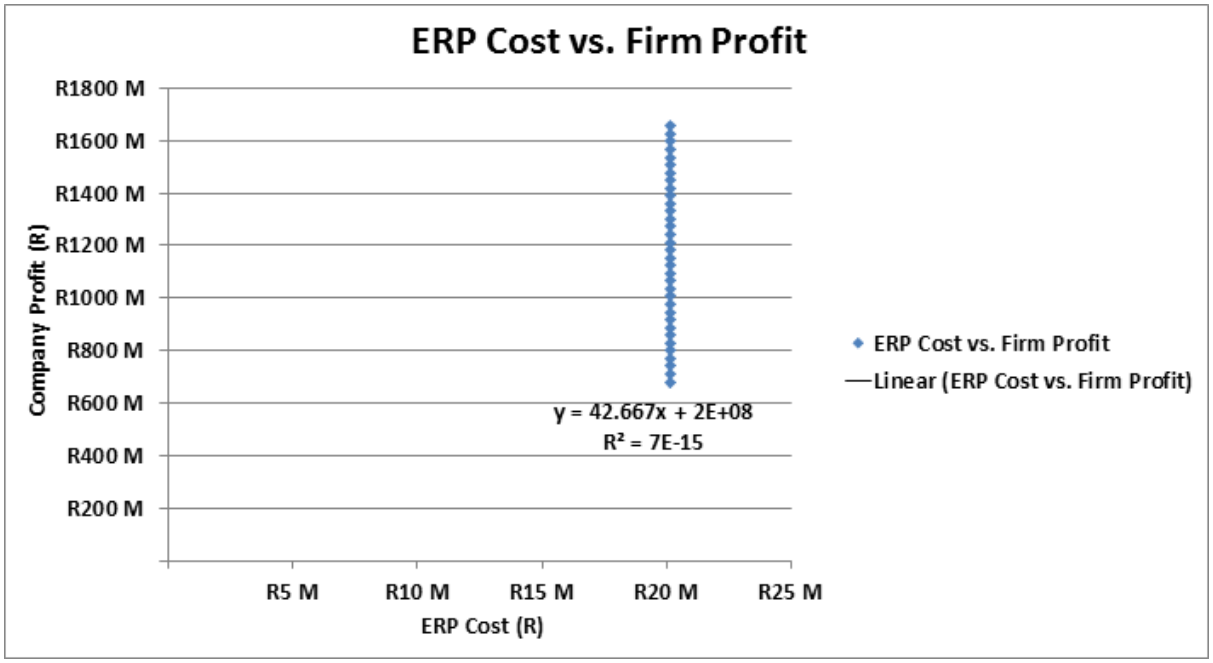

Figure 137: ERP Cost vs. Firm Profit

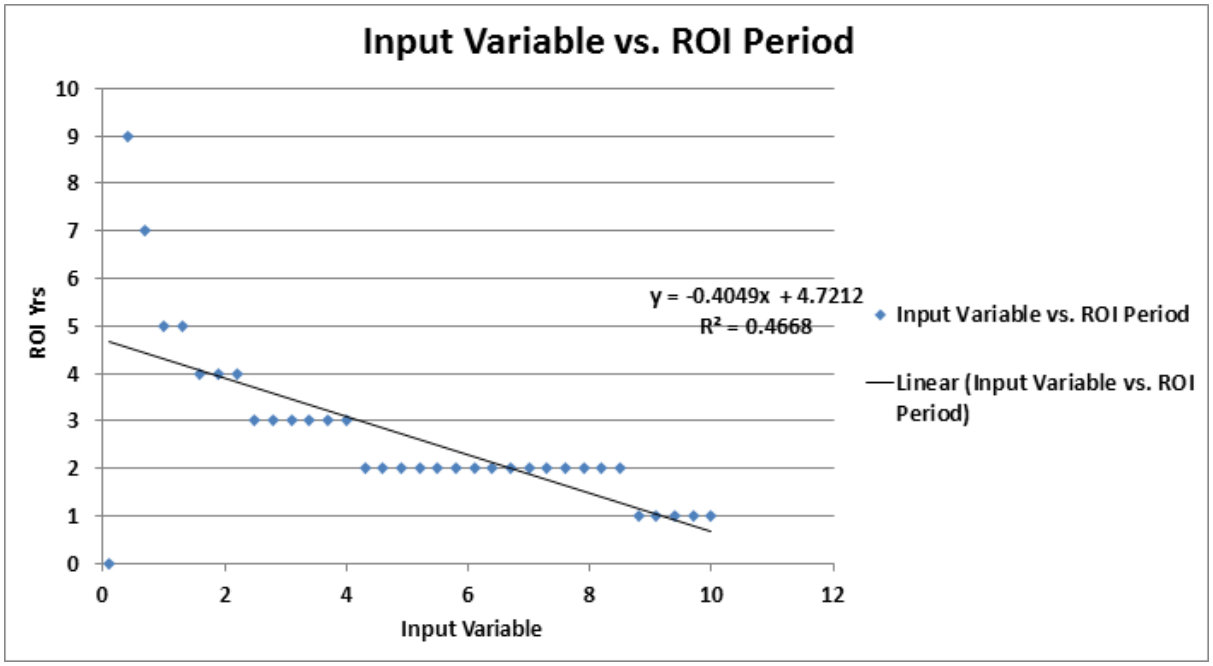

Figure 138: Input Variable vs. ROI Period

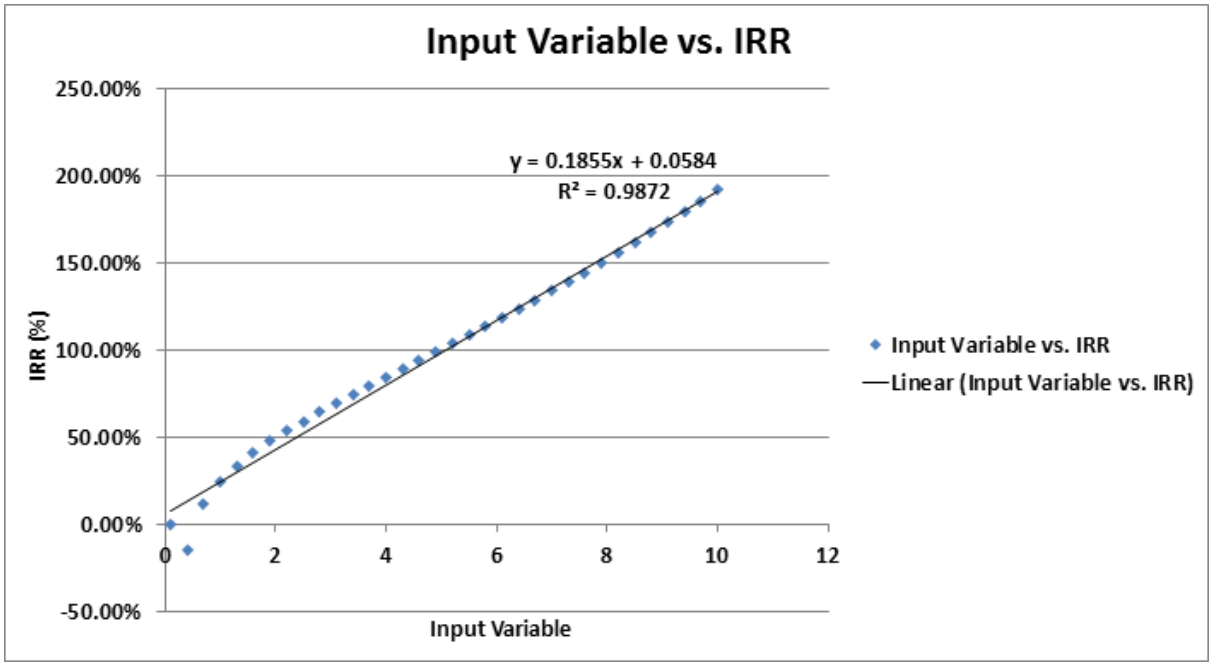

Figure 139: Input Variable vs. IRR

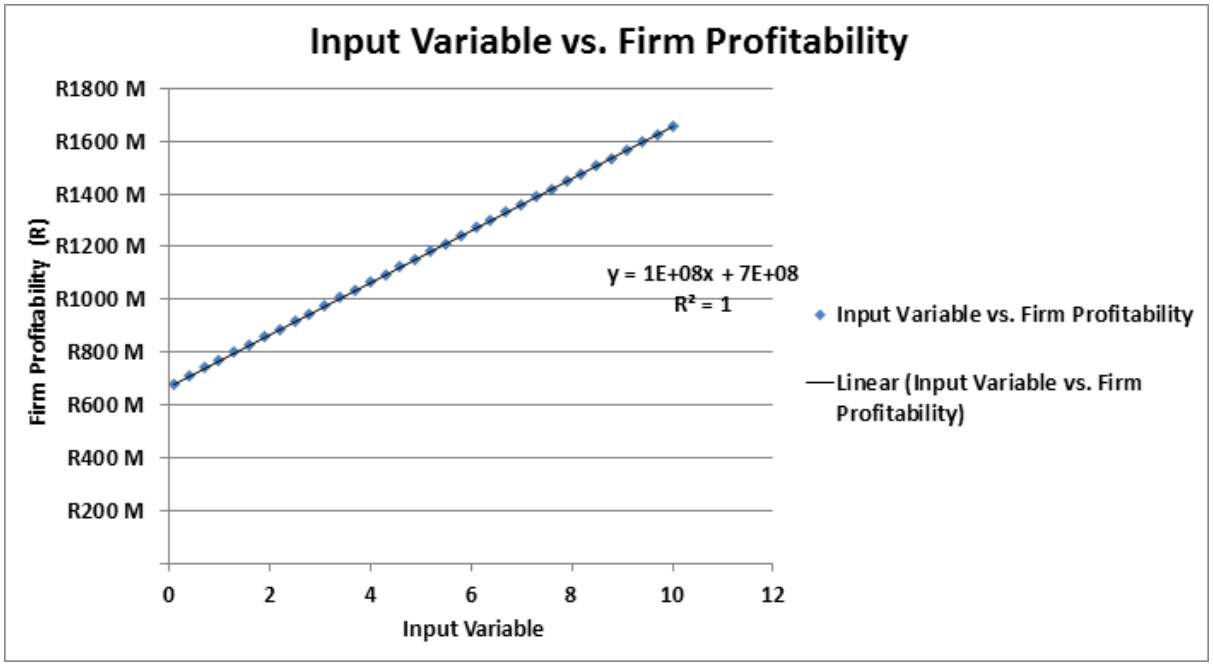

Figure 140: Input Variable vs. Firm Profitability

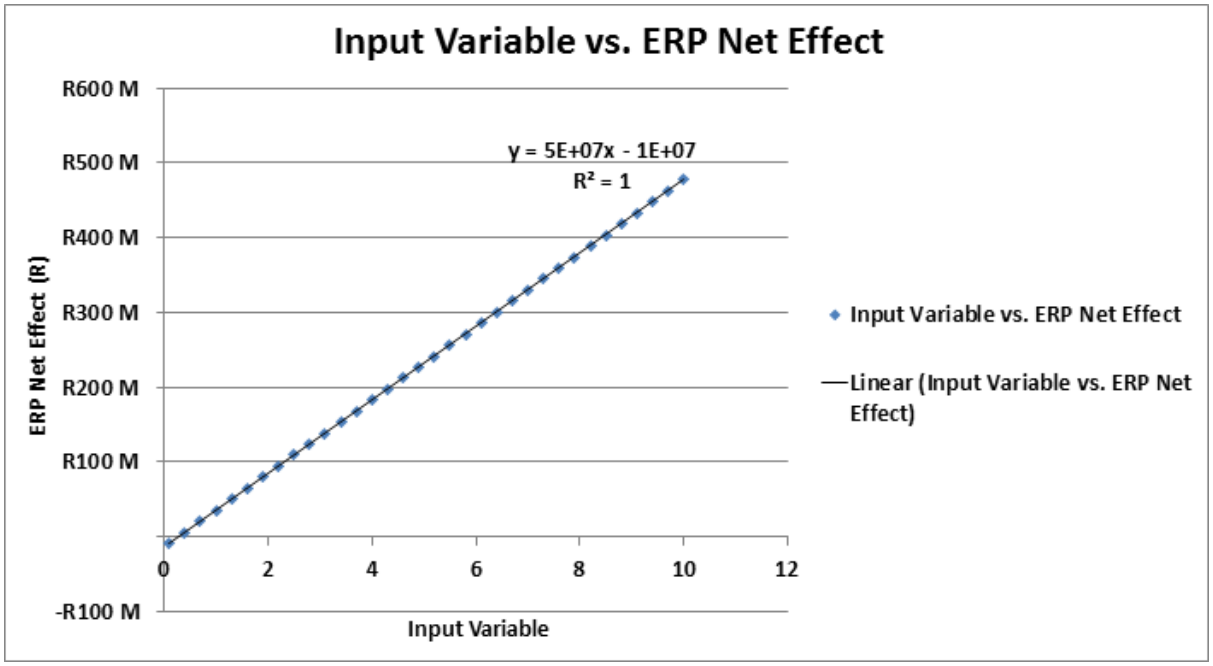

Figure 141: Input Variable vs. ERP Net Effect

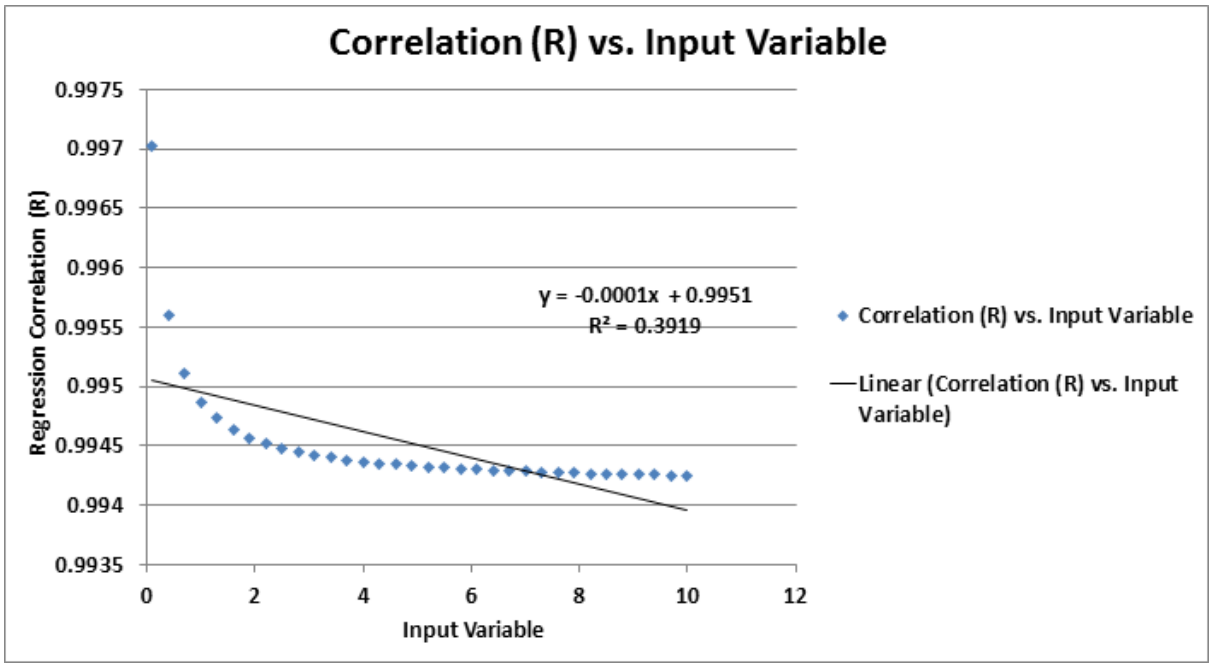

Figure 142: Correlation (R) vs. Input Variable

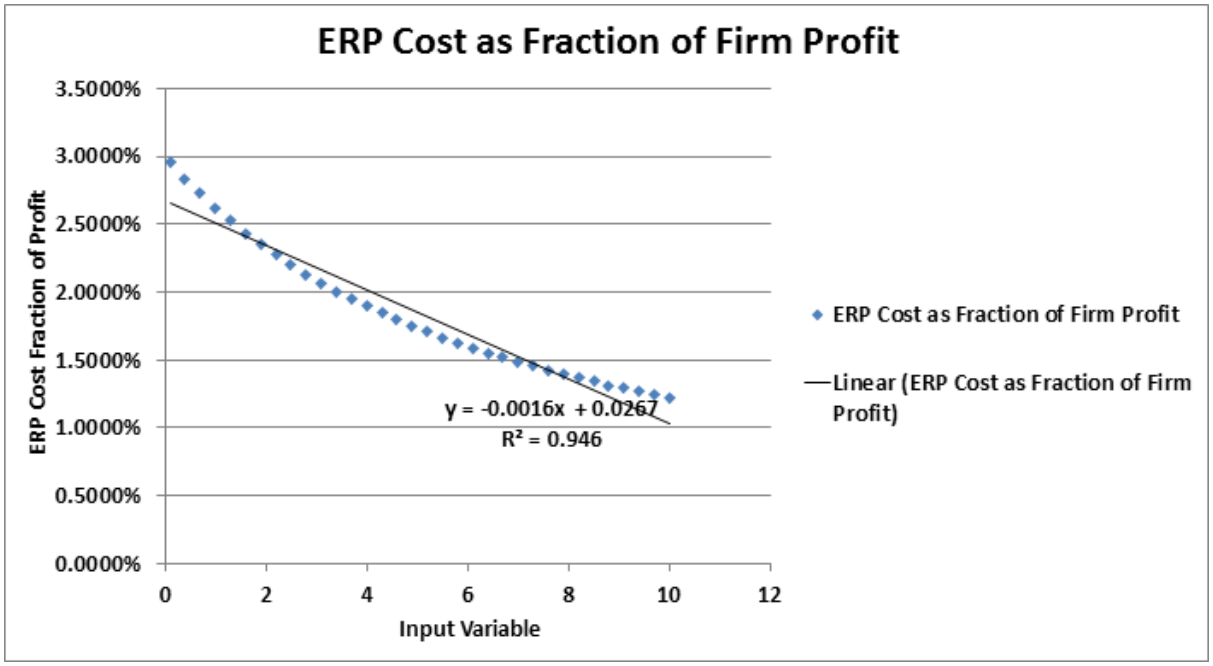

Figure 143: ERP Cost as Fraction of Firm Profit

8.1.1.10 Scenario 10: Inflation

8.1.1.10.1 Input Range and Step

Table 28: Scenario Input Range and Step Size

Range	0.1 to 10
Increment	0.3

The variable was stepped from 0.1 to 10 in increments of 0.3. This initial step (0.1) translates into a level of inflation at a tenth of the actual inflation whereas the last step (10) translates into ten times as high CPI as is actually experienced in South Africa over the measured period.

8.1.1.10.2 Results

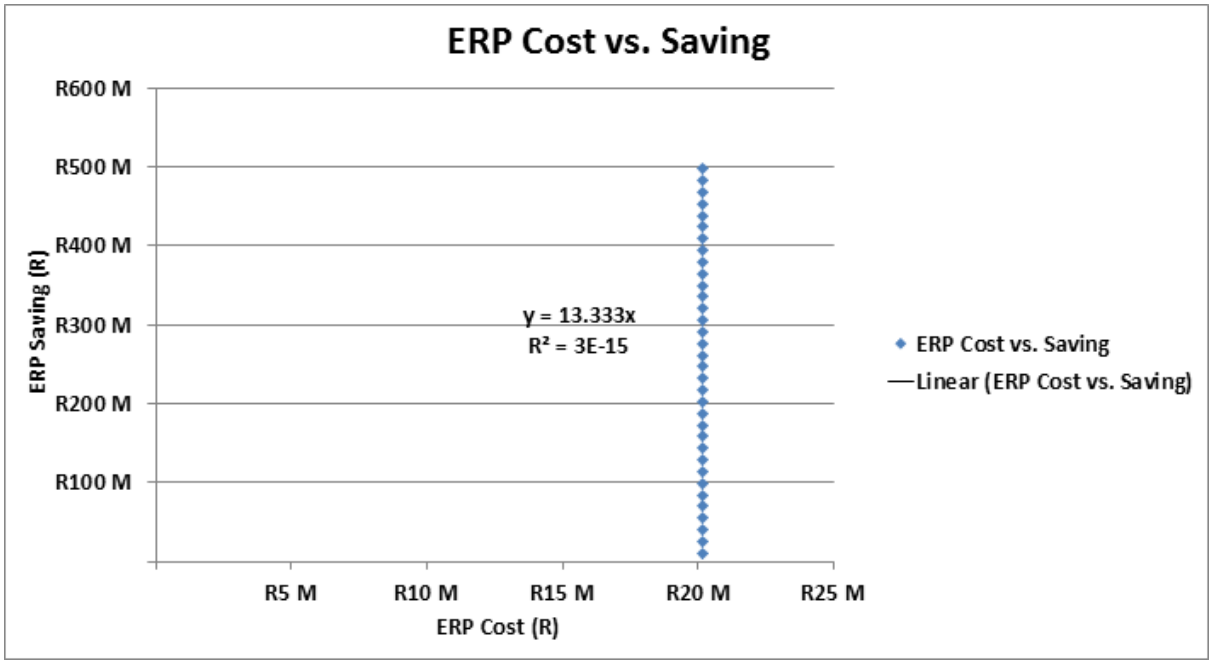

Figure 144: ERP Cost vs. Saving

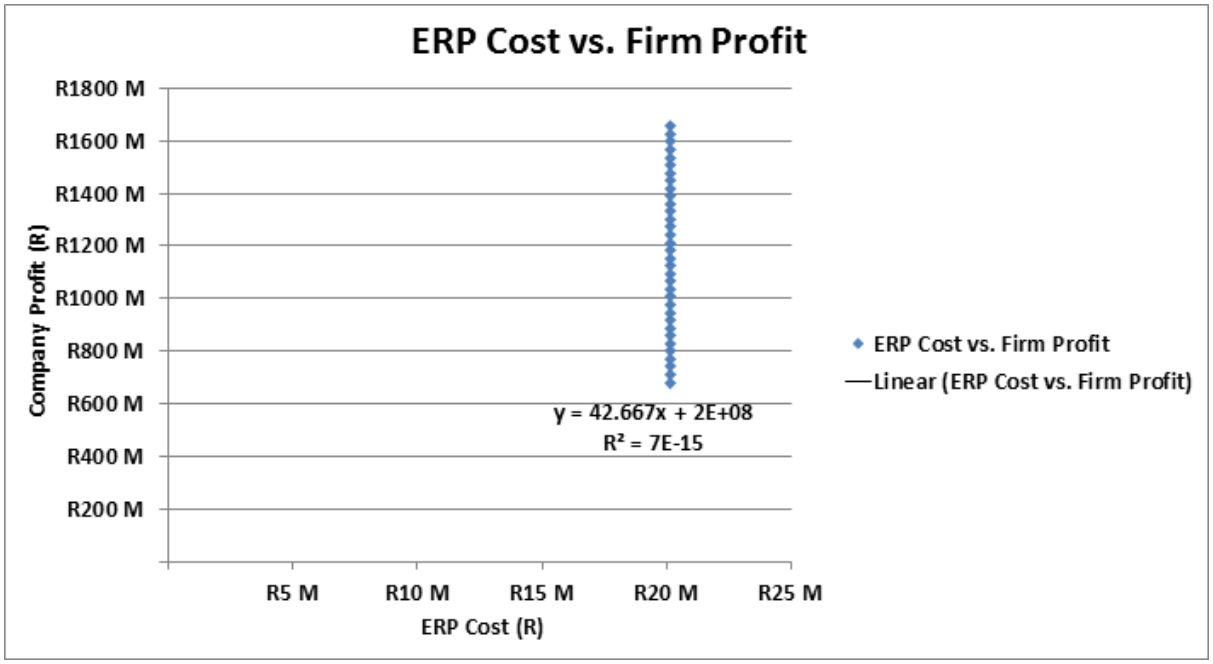

Figure 145: ERP Cost vs. Firm Profit

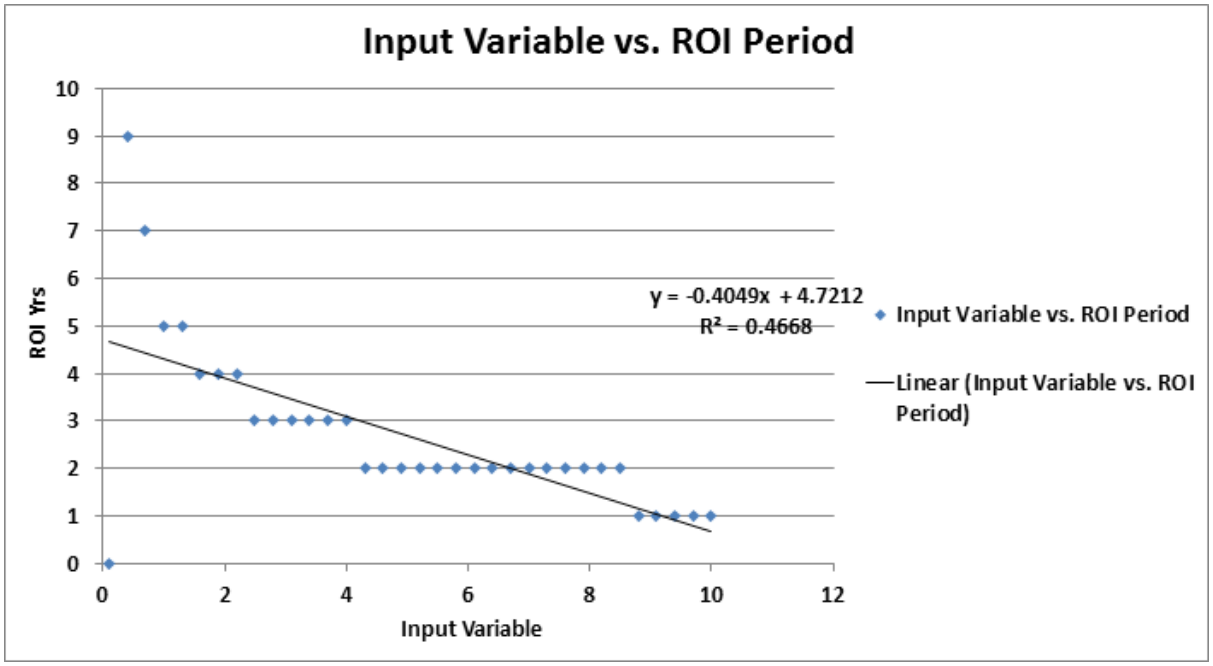

Figure 146: Input Variable vs. ROI Period

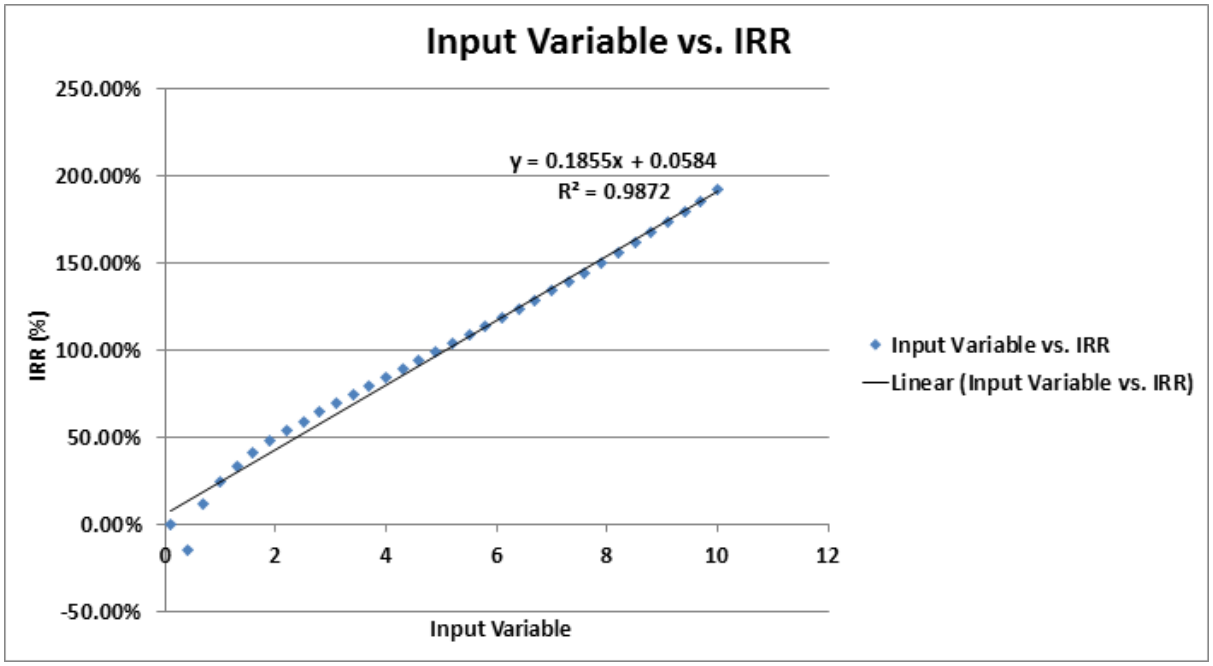

Figure 147: Input Variable vs. IRR

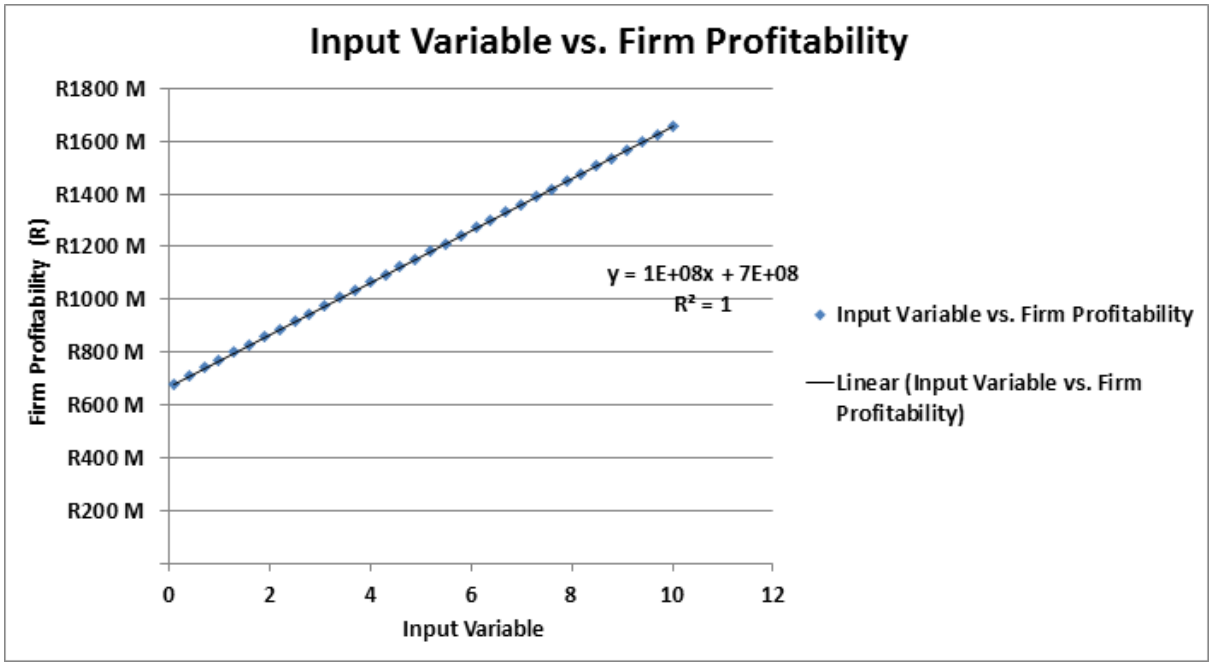

Figure 148: Input Variable vs. Firm Profitability

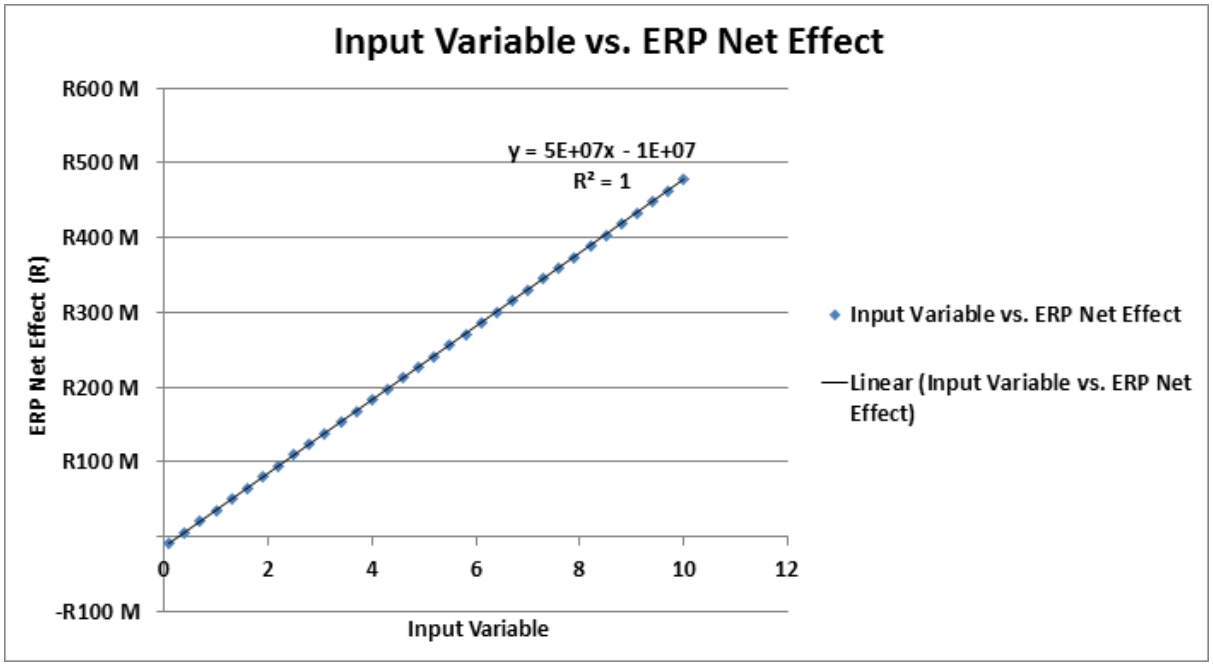

Figure 149: Input Variable vs. ERP Net Effect

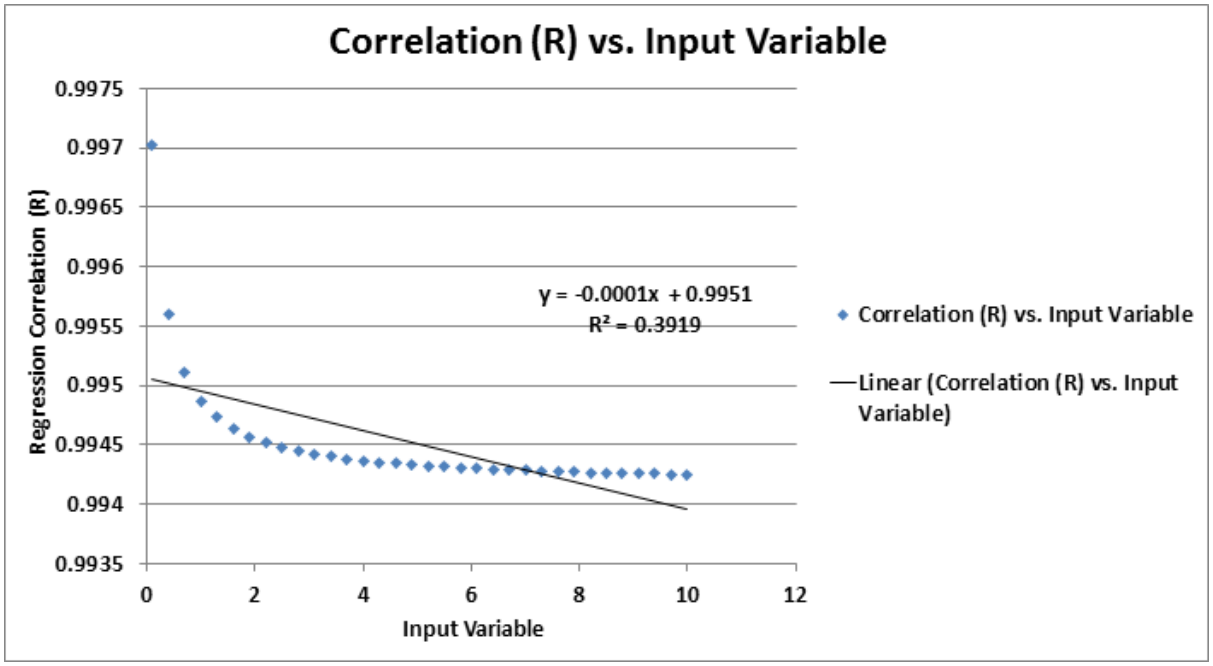

Figure 150: Correlation (R) vs. Input Variable

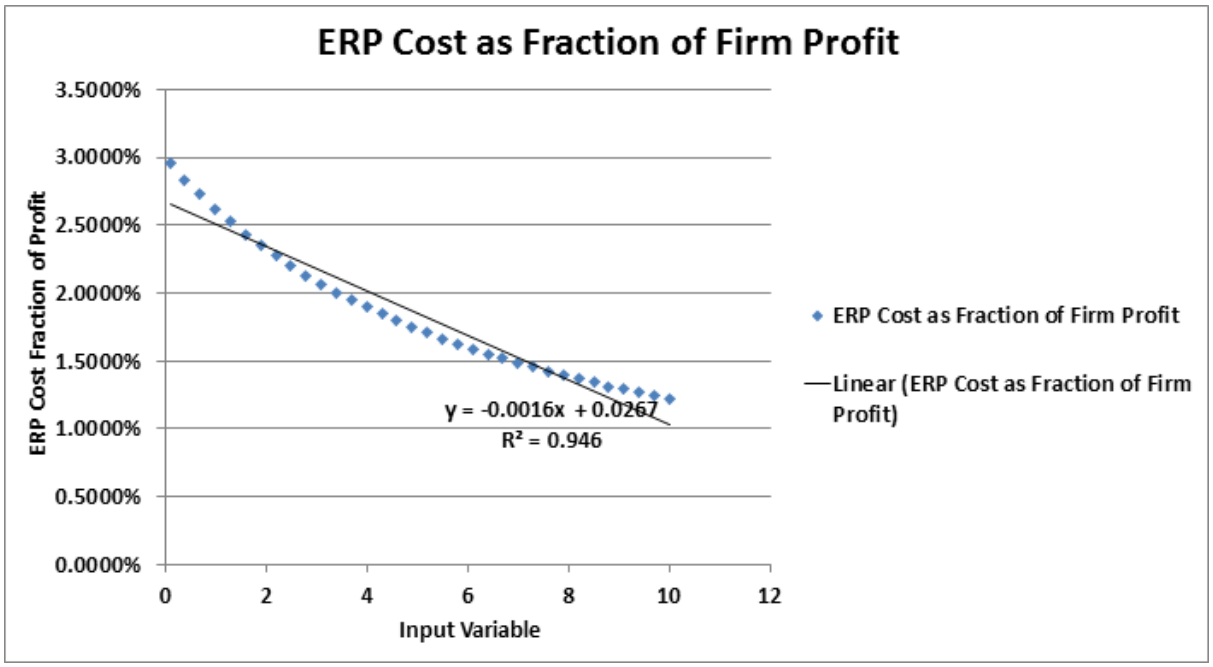

Figure 151: ERP Cost as Fraction of Firm Profit

8.1.1.11 Scenario 11: Only user license (Order Size var.)

8.1.1.11.1 Input Range and Step

Table 29: Scenario Input Range and Step Size

Range	10 to 400
Increment	10

The variable was stepped from 10 to 400 (exactly as in the other "Order Size" scenario) in increments of 10. Since the baseline model has a value of 100 for this input variable, the range will simulate order sizes from a tenth of the baseline model's through to four times as much as the baseline model.

8.1.1.11.2 Results

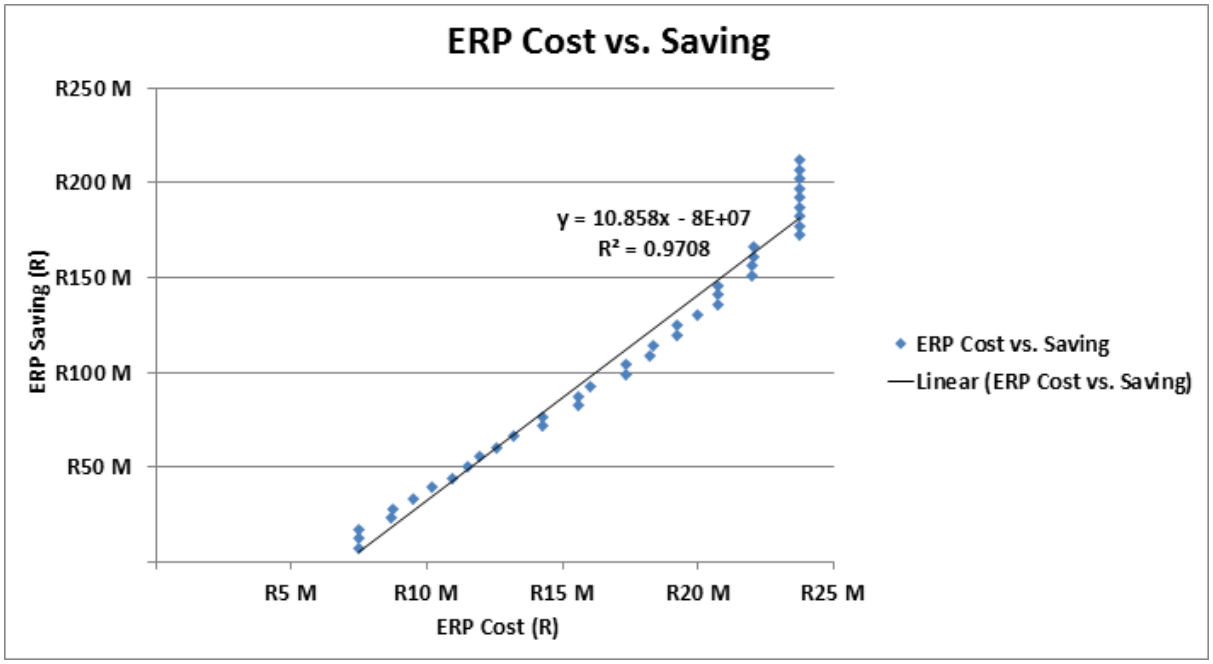

Figure 152: ERP Cost vs. Saving

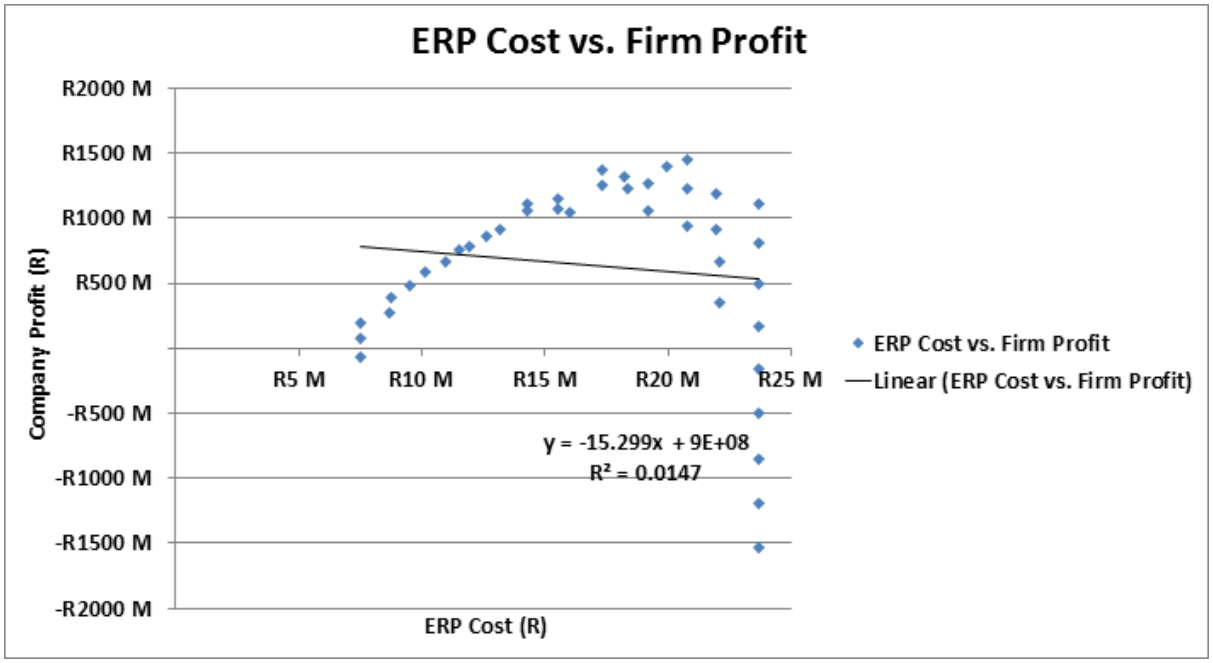

Figure 153: ERP Cost vs. Firm Profit

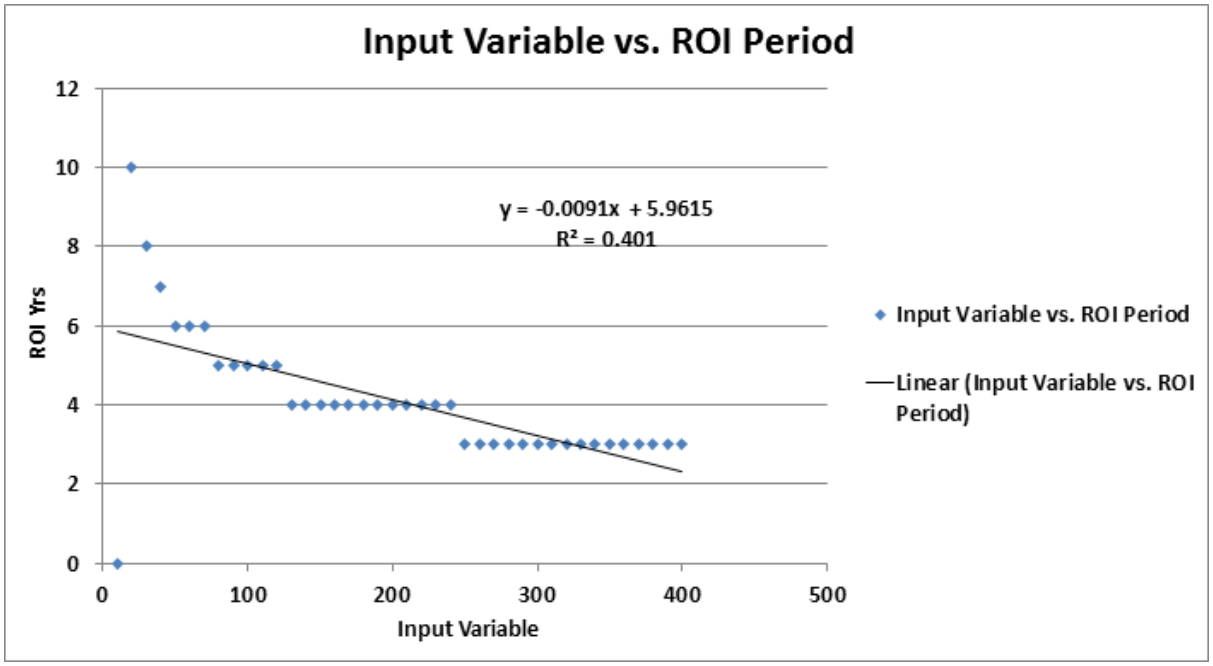

Figure 154: Input Variable vs. ROI Period

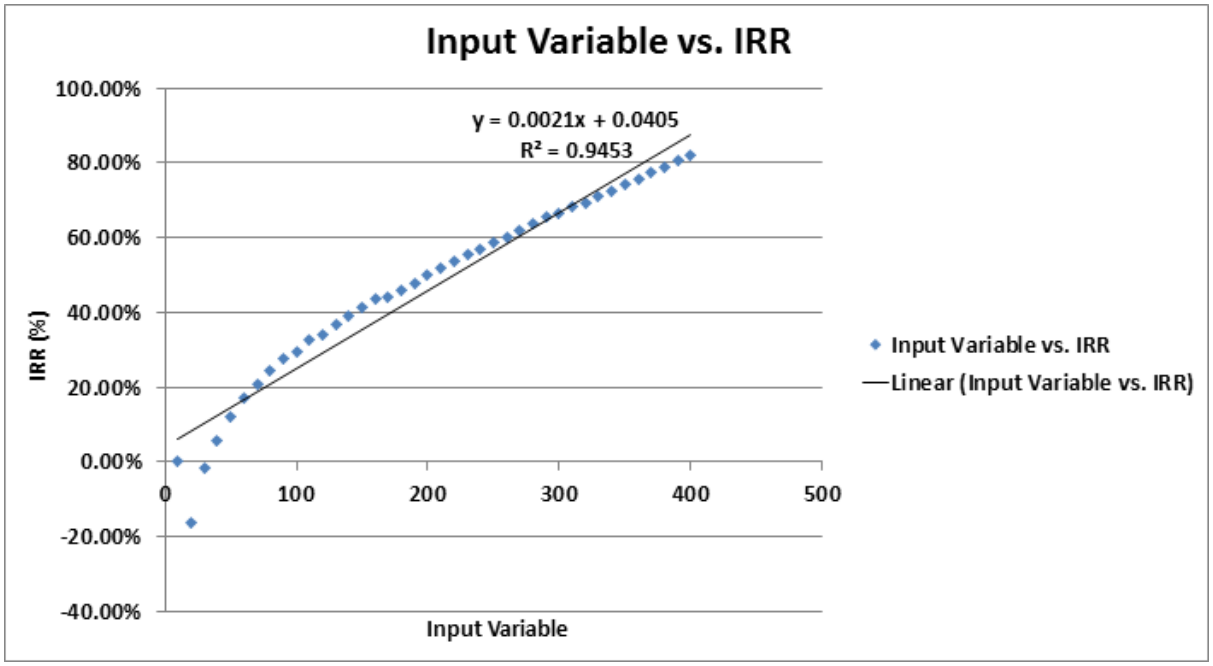

Figure 155: Input Variable vs. IRR

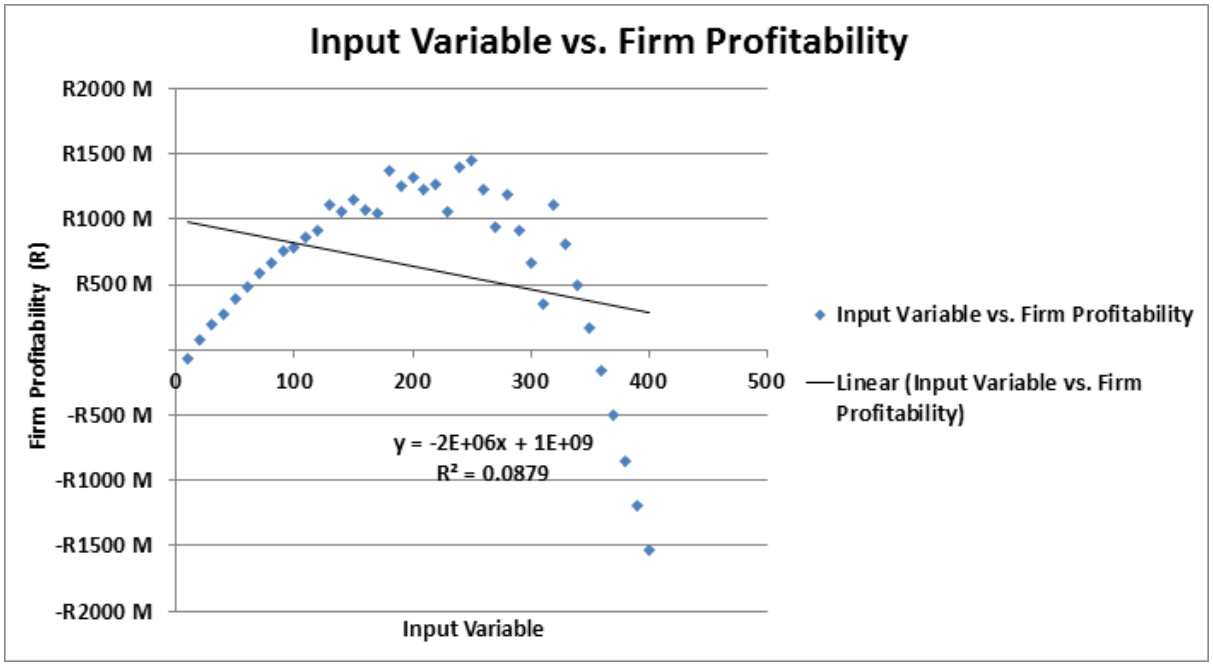

Figure 156: Input Variable vs. Firm Profitability

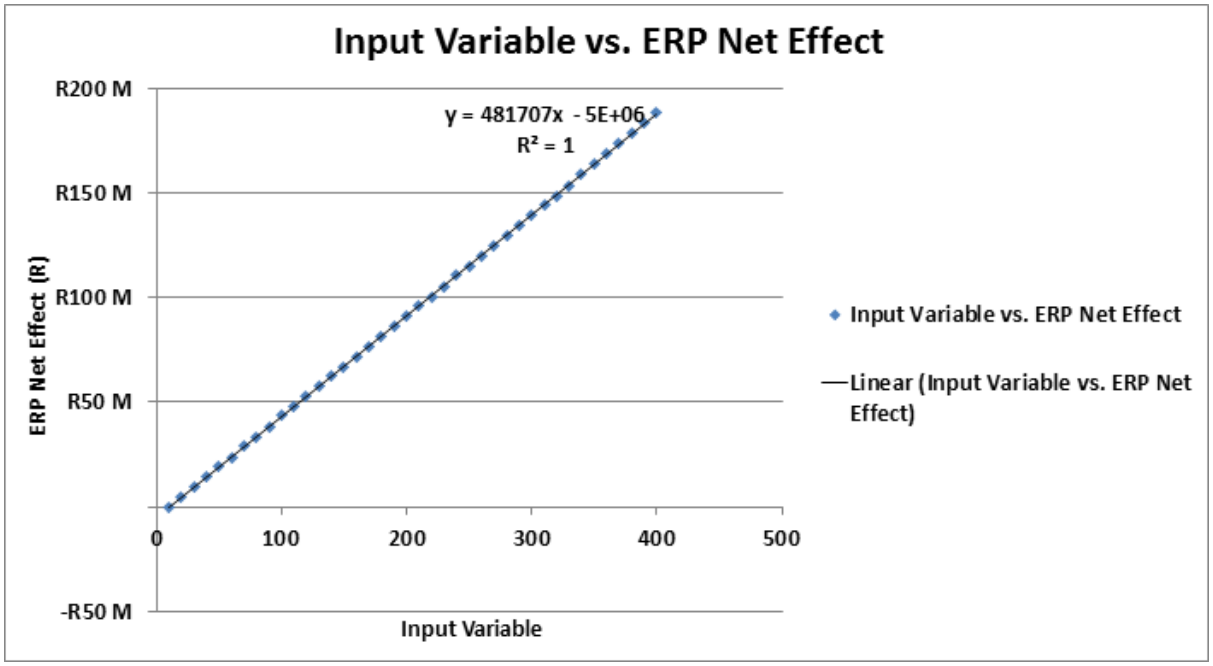

Figure 157: Input Variable vs. ERP Net Effect

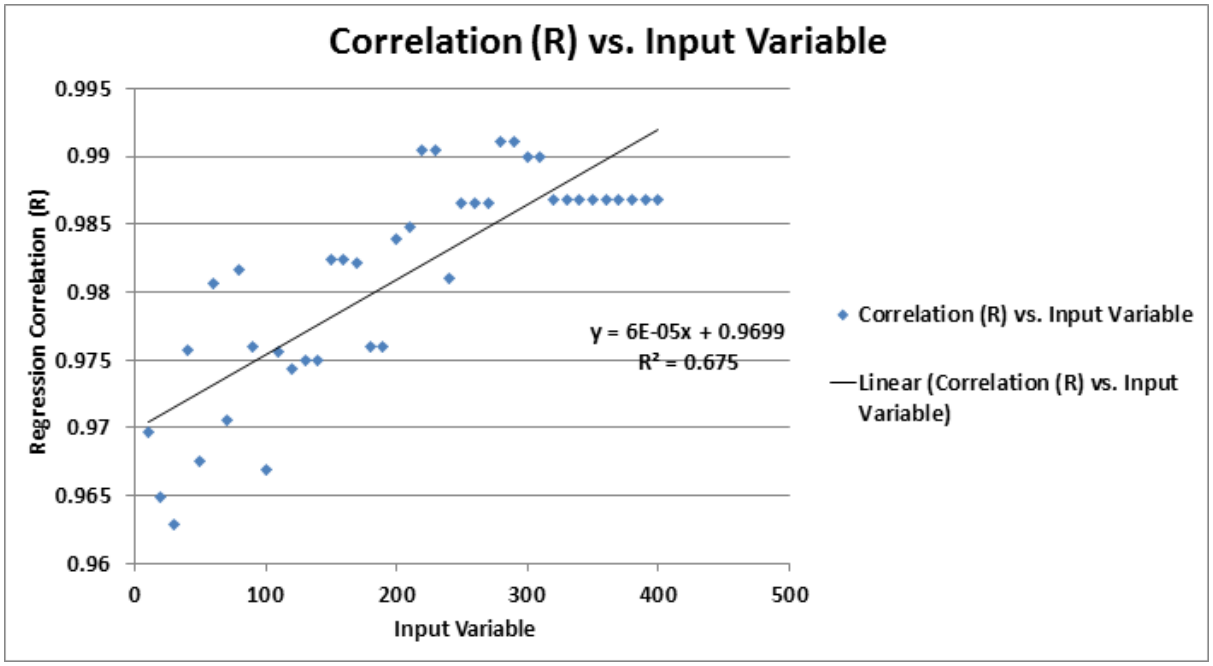

Figure 158: Correlation (R) vs. Input Variable

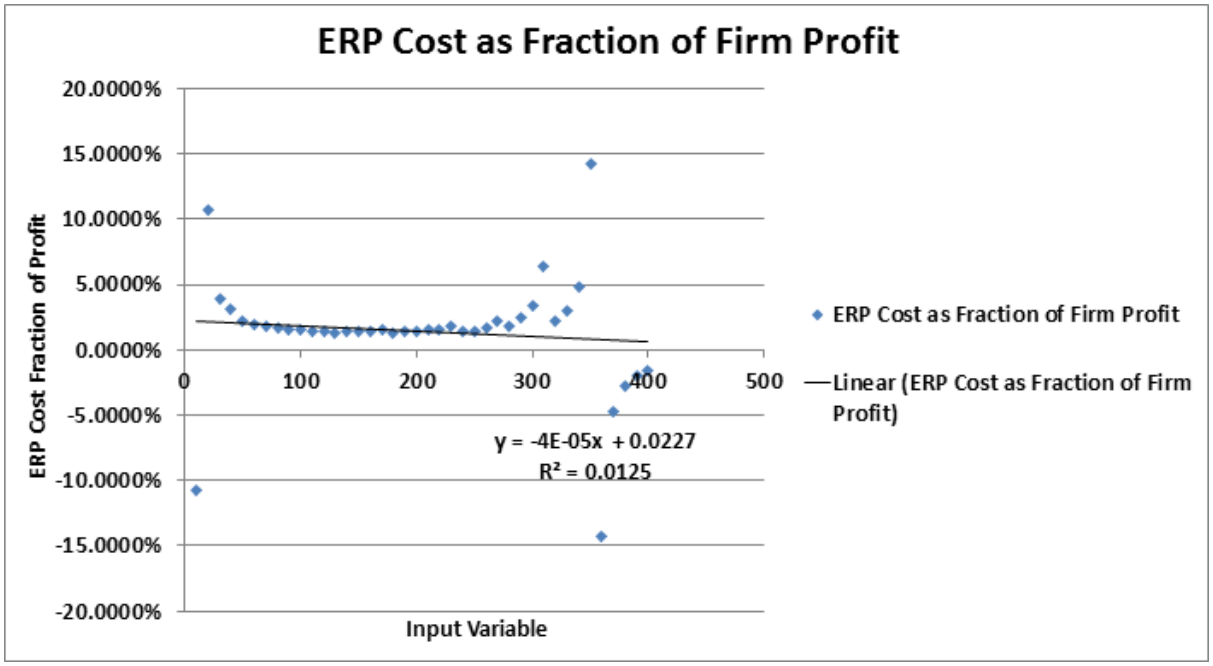

Figure 159: ERP Cost as Fraction of Firm Profit