Increasing Return on Assets through Insourcing Logistics

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ABSTRACT

Insourcing and vertical integration often allow companies to gain competitive advantage by exercising a greater degree of control over their supply chain. In the case of ABC Oilfield Services, insourcing the transportation of their products to offshore oil rigs at sea – a function currently provided by their customers – will increase asset velocity of their most important tools, and allow them to service more customers with fewer tools. This is an especially important consideration in light of the fact that the offshore drilling market will see double-digit growth in the coming years. This paper examines the effect of such increased asset velocity on Return on Assets (ROA).

Using detailed historical data of ABC shipments of their biggest revenue-generating tools, we modeled both the status quo logistics system of ABC, and an alternative system based on sound insourcing assumptions. We then compared the projected ROA of the two scenarios in order to gain insights into the relationship between insourcing and its likely effect on ROA. We attempt to quantify the asset velocity benefits of insourcing, but also show the surprising result that increased asset velocity can have a negative effect on revenue under common pricing schemes. While there may be several other factors which help in ultimately making the decision to insource, the paper provides an important contribution in helping decision makers see the effects of insourcing in the oilfield services industry more clearly, and identifying the conditions under which insourcing will have the biggest benefit to ROA.

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1 Introduction

Sourcing decisions are a critical part of business strategy; whether to produce a good or service oneself, or pay for an outside firm to produce it, remains a fundamental management question, with broad implications for the future of the firm. This thesis attempts to answer this question for an oilfield services company that is considering insourcing a portion of its logistics operations that is currently being performed by its customers. In order to conduct a sensible analysis, an understanding of the offshore oilfield services industry is necessary; this introduction provides background information towards that end.

1.1 Brief description of Oil Industry

Crude oil or petroleum has been the dominant source of world energy for several decades because of its unique attributes – high energy density, easy transportability and relative abundance. The Key World Energy Statistics Report, 2010 published by International Energy Agency displays this dominance of oil in Figure 1-1 in energy units of millions of tons of oil equivalent (mtoe).
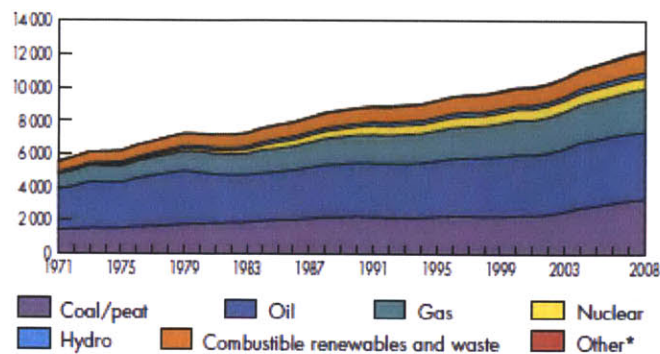
Figure 1-1 Evolution from 1971 to 2008 of world total primary energy supply by fuel (mtoe)

The global production of oil in 2012 is expected to reach 96 million barrels per day, an increase of 13 million barrels per day from the 2010 production level. This production increase will serve growing demand from emerging economies (*World Energy Outlook*, 2011). In short, oil has been the world's major commercial energy source, and will remain so for the coming decades.

The process of extraction is also popularly known as *oil drilling*, a complex process that requires experienced personnel and specialized equipment. A drilling rig, or *rig*, refers to the massive set of equipment required to drill a hole in the earth's surface and extract oil. Most oil companies, such as Exxon-Mobil or British Petroleum, do not operate rigs themselves, but outsource almost all drilling functions to specialists known as *drilling contractors*. In turn, the drilling contractors, such as Transocean, Ensco and Nabors Industries, outsource much of the technical expertise and equipment to drill to the depth and specifications set by the oil companies (Baker, 2001).

To successfully drill an oil well, the drilling contractor further needs more specialized equipment, supplies and services that it normally does not maintain itself. The set of companies which provide these supplies and services to the Drilling Contractors come under the umbrella of Supply & Services companies. The supply companies provide consumable and non-consumable items to the drilling contractors. The consumable items at a rig are items such as drill bits, fuel, lubricants and drill mud; non-consumable items include such equipment as drill pipes, fire extinguishers and other equipment which have a longer operating life (Baker, 2001).

Understanding the wide variety of supply and service companies is important because drilling contractors provide a common set of vessels that are often shared by the many supply and service

companies connected with a given rig. These companies offer very specialized support to the drilling operation, such as mud logging, well logging, cementing, and logging-while-drilling. For instance, a well logging company provides extremely sophisticated instruments when the drill hole reaches a formation inside earth where there is high probability of finding oil. The logging instruments sense and record formation properties which are then communicated to computer servers on the rig. This information helps in the assessment of the formation (Baker, 2001). To summarize, the oil drilling is an extremely unique process which requires the specialized contribution of several stakeholders ranging from drilling contractors to the services companies.

1.2 Company Description

Our thesis partner, ABC, is a leading oil supply and services company whose drilling and measurement division rents out highly specialized equipment to drilling contractors. Most of the equipment falls under the category of Logging–While–Drilling (LWD) tools. LWD tools, which are attached to the drill bit to form the *drill string*, administer, interpret and transmit real-time measurements of geological formations that the drill string passes through as it bores its hole in the earth's surface (rigzone.com, 2011). ABC provides its services to drilling contractors around the globe, on land-based rigs, as well as offshore rigs at sea. The focus of our thesis is however is only on ABC's services to offshore drilling oil rigs.

ABC procures these sophisticated tools at costs of several hundred thousand dollars each (ABC Management). These tools are maintained at a base location which also serves as a customization

and maintenance facility. The tools are picked up from the maintenance facility by the drilling contractors, trucked to a dock, and then transported by boat to offshore rigs for use. The time that a tool stays on a rig depends on the unique circumstances of that drilling operation, but typically last from 1 to 3 weeks. Once the customer has finished using the tool, the tool is returned to the maintenance base by the reverse route, where it is refurbished for the next use. The average operating life of a tool is approximately 48 months.

1.2.1   Price Structure of rental services offered by ABC

ABC typically is paid two types of charges while the tools are being rented: *standby* and *operating* charges. The Operating charge is only applicable when the tool is actually being used in the drilling process; that is, when the tool is physically attached to the drill bit on a drill string and inserted below the floor of the oil rig, or 'below the rotary table' (BRT) in industry terms. Standby charges, on the other hand, are applicable at all other times, including when the tool is being transported to and from the rig, and when it waits on the rig before and after usage ('*waiting time or 'standby time*'). Although the exact charges (or daily tool rental rates) are negotiated on a case-by-case basis, the standby charges are almost always less than the operating charges.

Under the status quo, the customers (drilling contractors) are responsible for all transportation in the process described above, to include hiring of trucks and boats, scheduling pickups and deliveries, and all associated costs of moving these tools.

1.3 Motivation

In the periods of falling demand from 2008 to 2010 (see Figure 1-2), ABC has found its Return

on Assets (ROA) decreasing as the overall profits decreased while investment on rental assets

remained more or less constant. (Return on Asset for this business can be simply understood as

the ratio of Net Income to the Investment Value of Rental Assets). The Return on Asset (ROA) is

an important metric used to assess the financial position of a company. Therefore, the decreasing

ROA is a cause of concern for the company, and this paper is a part of an attempt to study the

insourcing logistics option to reverse the trend of declining ROA.
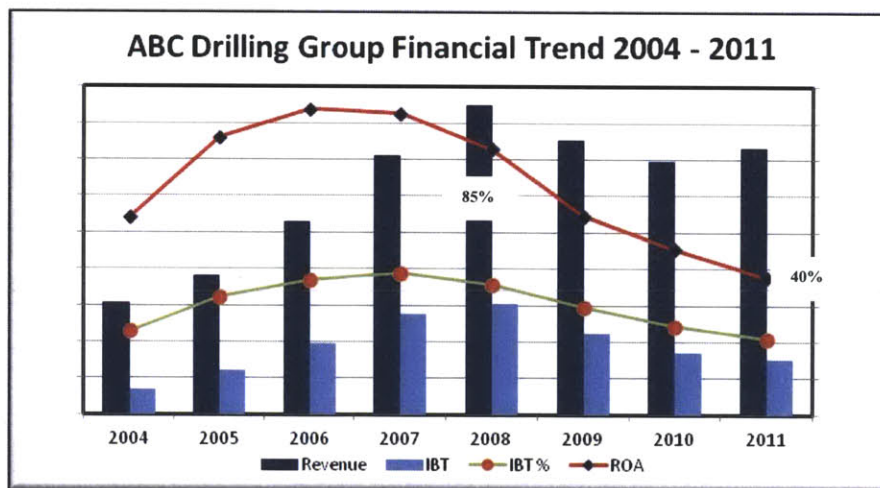
Figure 1-2 Declining trend of ROA from 2008 onwards (masked values)

We hypothesize that one way to increase ROA is to cut down the amount of waiting time (time

on a rental trip when tool is not being used) for a tool; decreasing the waiting time allows each

rental trip to be shorter, and thereby allow the tool to go on more trips, which would conceivably

have two important effects. First, a greater number of possible trips may mean that the same tool

could now generate more revenue. Second, an overall fewer number of tools could be used to serve the same demand. These two possible effects could have a positive impact on ROA, as Net Income increases while the Investment on Rental assets decreases or at least remains the same.

Improving ROA becomes even more of an imperative as demand for LWD tools is expected to grow as much as by 70% in the next few years. The high cost of tool production and limited production capacity both add to the need to maximize ROA (ABC Management).

1.4   Research Question

Standby time can be reduced in various ways, two of which the company is already attempting. First, the company is considering an information system which relays an accurate status of a tool at a customer location so that requisite action can be taken to expedite its return. Second, ABC is considering the appointment of a Tool Traffic Controller, who would actively monitor the tool status at various customer locations and then take actions to expedite return.

During our site visit to an ABC facility in Louisiana, managers offered other possibilities to reduce Standby time, such as managing return logistics from customer locations, managing forward logistics to the customer location, split shipments, and rig-to-rig transfer of tools. However, the focus of our study is limited to the issue of managing return logistics only. Because of the extreme risk to upsetting the customer's drilling schedule, ABC is not considering insourcing the outbound leg of tool transportation; the inbound leg, in contrast, is the least risky portion of a tool's cycle, and as such the natural place to start a sourcing initiative.

Thus our research question can be stated as: Should ABC manage the return journey of rental trips on its own as opposed to the current practice of the customer handling the entire logistics?

1.5   Thesis Organization

This thesis is organized into six parts. Following the introduction, we will examine the scope of insourcing logistics at ABC and the value which may be gained through insourcing. We will then conduct a Literature Review centered on two themes relevant to our paper: Dupont Analysis, and Insourcing/Vertical Integration. Drawing on the frameworks of these themes, we will detail the process of Modeling ABC Logistics using four integrated models: Time, Revenue, Costs, and Return on Assets. After explaining the models and the processes they represent, we will then explore the Results of these models applied to three distinct scenarios, followed by a Sensitivity Analysis of the results across a range of possible scenarios. In doing so, we hope to answer the Research Question and increase understanding of the financial dynamics of ABC's operating environment. Last, we will suggest Areas of Further Research.

2   The case for insourcing logistics at ABC

One of the core purposes of this research is to understand the financial impact of the insourcing the logistics function. The understanding of the financial impact becomes even more important for ABC as it faces increasing demand in the next few years.

2.1   Meaning of Insourcing Logistics at ABC

Confusion is likely to arise on account of the unique case of ABC's current logistics footprint. The literature on Outsourcing and Insourcing frames most business problems as a question of whether to insource – that is, to perform a business task or service with resources that are inside the boundary of the firm; or to outsource – to contract an outside company such as a third party logistics provider (3PL) to perform the task on its behalf. In this traditional paradigm, insource broadly connotes a move towards greater control over the performance of the task; and outsource means a contractual delegation of the task to an outside agency, thereby relinquishing decision-making power to the third party. In our study, when we refer to "outsourcing", we refer to the status quo logistics situation, in which the client arranges for logistics with little or no involvement from ABC. Conversely, we will refer to "insourcing" as the general move towards assuming responsibility for the logistics function, without regard (except where explicitly stated) for whether ABC will choose to buy their own boats or hire an outside agency (such as a 3PL) to accomplish the task.

In the case under consideration here, however, the question is – in the traditional sense -- not an insource or outsource issue; but rather, a decision on the part of ABC to take responsibility of a task for which it currently has little or no responsibility. Should ABC decide to take responsibility for the logistics functions in question, only then will they be faced with the question of whether to insource or outsource the task (in the traditional sense). In fact, all indications from ABC are that they are not considering making the large capital investments necessary for them to truly insource their own logistics – that is, buying their own boats. In all likelihood, should they choose to change the status quo, ABC will outsource the task to a 3PL on the basis of some leasing or rental arrangement. The question at hand, then, is whether ABC will outsource the function, or continue to allow the function to be outsourced by their clients. Therefore, to strengthen our analysis, we will look toward the existing body of literature on the topics of both vertical integration and insource/outsource.

2.2 Description of tool trip

The Space – Time diagram (Fig. 2-1) provides a good description of the rental trip of a tool. It clearly shows the various locations a typical tool passes through in a rental trip. The Green dot represents a tool ready for usage and a Red dot represents a used tool. The blue solid arrows represent the forward trip of the tool till the rig and its usage below the earth surface (also called Below Rotary Table, abbreviated as BRT). The blue dash arrows represent the retrieval of the used tool from below the surface of earth to rig. Thereafter, it represents the return trip from the rig to the tool base. The black arrow represents the time elapsed in maintenance of a used tool

before it can be used again. The used tool is known as a Red tool and the tool ready for usage is known as a Green tool.
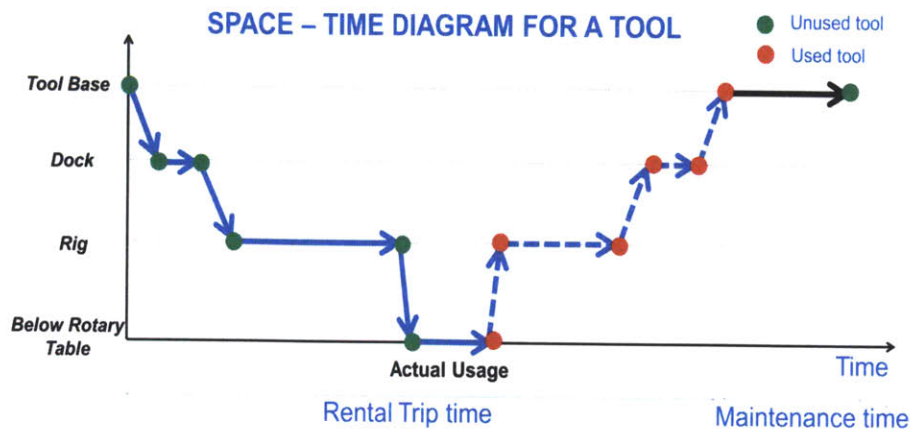
Figure 2-1 Journey of a tool through various points captured in a Space-Time diagram

The following table (Table 2-1) shows an alternate description of the tool rental trip with the various parts of a typical rental trip. Please note that the maintenance time is not included as a part of tool rental trip.

Table 2-1 Types of activities performed along the tool rental trip

Description of leg of rental journey	Activity Time	Type of Activity
Trip journey till Rig in the forward leg	Time to Dock	Transport
	Time at Dock	Waiting and Loading
	Dock to Rig	Transport
Trip journey at Rig	Storage before Run	Unloading & Waiting
	Below Rotary Table (BRT) Time	Actual Usage
	Storage after Run	Waiting & Loading
Trip journey after Rig in the return leg	Rig to Dock	Transport
	Time at dock	Unloading & Waiting
	Dock to Base	Transport

It should be noted that the diagram (Figure 2-1) is only an illustration of a rental trip of a typical tool which is actually used below the rotary table. However, in any trip there are back-up tools which may not be used below the rotary table. These back-up tools would have the same trip profile as the used tool excepting the below rotary table part. The back-up tools wait at the rig when one of the tools is being used below the rotary table. The used tool and back up tools typically go to & return together from the rig.

2.2.1   Note on Green and Red tools

Again, it is important to remember the terminology of Red tool and Green tool going forward in thesis as they will be referred often the course of this thesis. The following definitions can be used for Red and Green tools:

- *Red Tool* – The tools, amongst the set of all tools sent to a rig location, which are used below the rotary table. The actual usage of these tools as an implication on the maintenance time once these tools are back in the tool base. These tools have substantially long maintenance times associated with them to get them ready for usage.

- *Green Tool* – The unused tools which are ready for usage are known as Green tools. A Green tool becomes a Red tool after usage. Since the back-up tools end up not being used at the rig therefore end up being Green tools. The fact that these tools are not used also has an implication on the maintenance times. Green tools have substantially shorter maintenance times associated with them once they are back at the tool base.

Any tool can be Red or Green depending on whether it is used or not. It should be noted that there are no special 'Green' or "Red' tools. This is merely a terminology used to indicate the usage status of the tool.

2.3 Inferences from Rental trip time and Maintenance time

For a particular tool, rental trip times and maintenance times will vary with each trip. However, the average rental trip time and average maintenance time can be used to gather some insights about the service capacity. For this purpose, it will be useful to define the End-to-End Cycle Time.

End-to-End Cycle Time = Rental trip time + Maintenance time.   **Equation (2-1)**

The End-to-End Cycle time can be understood as the time duration between one Green state of a particular tool to the next Green state of the same tool. In between, the tool may be used where it changes its state to a Red tool. Therefore the expected value of the End-to-End Cycle Time can be inferred as follows –

E (End-to-End Cycle time) = E (Rental trip time) + E (Maintenance time). **Equation (2-2)**

The E (Duration) in the equation above denotes the expected or average value of the duration.

From the End-to-End Cycle Time we can estimate the expected Maximum Number of Trips achievable for a tool in a year by using the relationship,

E (Maximum Number of Trips achievable for a tool in a year) = 364.8/ E (Total Cycle Time)

(364.8 = 12 * 30.4, as 30.4 days consist of a working month in ABC)

Equation (2-3)

The Maximum Number of Trips achievable for a tool in a year represents the service capacity of the tool on annual basis.

There are different types of tool families within ABC which have distinct purposes of usage at the rig locations. Each type of tool within a tool family is similar and has the same purpose to serve at the rig location.

Under the assumption that all the tools within the same tool family have the same E (End-to-End Cycle Time), we can calculate the total capacity of a particular tool family with N tools from the relationship,

*E (Maximum Capacity for Tool Family) = N * E (Maximum Number of Trips for a tool in a year).*
Equation (2-4)

2.4   Scope of time savings in rental trip time through insourcing logistics

It has been observed that there is a possibility of reducing the rental trip time. The waiting time at rig (Storage before run and Storage after run) represents 50% of the time spent in average on a typical rental trip.
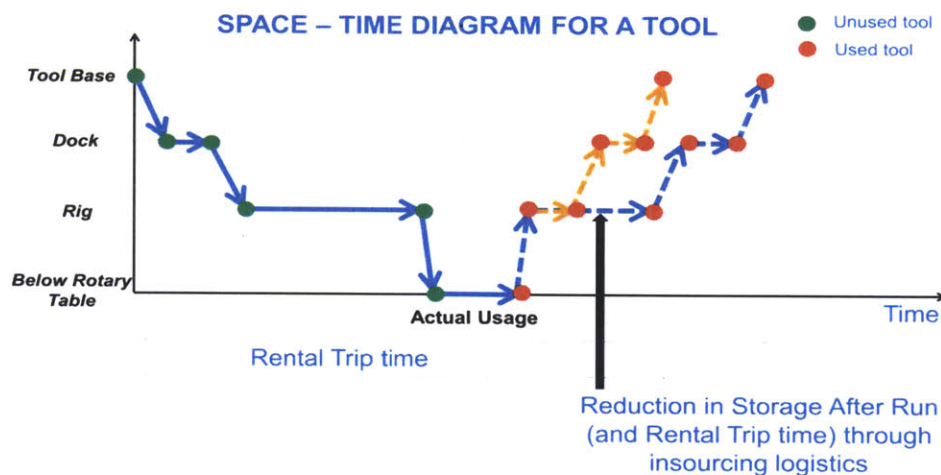
Figure 2-2 Scope of reduction in rental trips through the return journey time decrease

Our interviews with ABC Management and other stake holders in marine transportation yielded several reasons for these inefficiencies –

○ *Operational Priorities:* Although it may be in ABC's interest to retrieve the tool as soon as possible after the usage, the rig operator has several other critical tasks to complete. A lower priority associated with the return of ABC tools is the primary reason behind the storage after Run component.

○ *Shipment Consolidation:* The consideration of consolidating loads for incoming boats to rig and outgoing boats from the rig also causes delay. ABC's tools are only a small part (in terms

of weight and volume) of the entire set of tools being shipped to and fro from the rig. Therefore ABC tools have to wait at the rig and dock before shipment is possible. This issue affects both the storage before run and storage after run components.

- o *Planning Buffer:* Planning buffer represents a major cause of the storage before run component. There is a safety factor (in the form of planning buffer time) taken by the rig operator while ordering tools to ensure that these tools always arrive on time. It must be remembered that ABC's drilling and measurement tools are only one part of the entire gamut of activities undertaken while drilling. It is very likely that planning is guided by certain more expensive and critical activities, allowing the rig operator absorb the extra cost of calling in drilling and measurement tools earlier than required.

At present, ABC Management believes that it is prudent to control the return journey of the tool only. There are several reasons cited for this aspect –

1. The rig operator is likely not to have an issue with tools leaving the rig after usage.
2. Since a complete shift of management of logistics is not possible in a short term. The return journey logistics presents a good and safe start to the long term objective of ABC to control the entire logistics of the entire trip.
3. The forward trip is sensitive to the rig operator as timely arrivals are critical for the million dollar operations at the rig. It is believed that the rig owners will not give up the control for this leg of the trip in near future.

2.5   ABC's Logistics Options

ABC has two primary options to managing logistics:

1. Maintain Status Quo. ABC's customers (the rig operators) continue to manage the logistics of the rental trips as they do now. In order to precisely compare the effect of alternative Insourcing processes against Status Quo processes.

2. Insourcing Logistics. In this option, ABC increases the asset velocity of its tools (reduces the Waiting Time during a tool's trip) by insourcing, or managing its own logistics. By decreasing the End to End Cycle Time, ABC can meet a higher level of demand with the same number of tools, as the current status quo.

Our objective is to evaluate the financial impact between the two options, primarily in terms of Return on Asset; the option with the higher ROA will be the better option.

3 Literature Review

ABC faces the complex tradeoffs of operating any high capital equipment rental business. The first tradeoff is between capital expenditure in procuring rental assets and operational cost of asset utilization. The second tradeoff is between capital expenditure on rental assets and the service level provided to the consumer.

Our literature review is driven by the two major themes of the project: increasing Return on Assets, and managing one's own logistics. The fact that the key driver behind this project is to help ABC increase its Return on Asset (ROA) warrants a deep dive into what this often-used financial metric means and how it is related to the managing of one's own logistics by company ABC. With a better understanding of ROA, we will then turn to the question of insourcing, since managing one's own logistics means insourcing many of the functions currently being managed outside of the firm.

3.1 DuPont Analysis: Return on Equity

It will be useful to begin by understanding another financial metric, Return on Equity (ROE), which is used extensively by investment analysts to gauge the financial attractiveness of a company (Rothschild, 2006). In the same paper, the author argues that despite being an important metric, ROE does not provide any clue to identify the factors that are influencing it and that could possibly act as levers for improving it. It is here that the DuPont analysis,

developed by the DuPont Corporation in the 1920s, can help shed more light into the factors behind the often used metric ROE.

$$\text{Return on Equity (ROE)} = \frac{\text{Net Income}}{\text{Shareholder's book value of equity}} \qquad \textbf{(Equation 3-1)}$$

Net Income for a period can be obtained from the published Profit & Loss account of any company. Shareholder's book value of equity can be obtained from the published Balance Sheet of any company.

The DuPont Analysis is a simple decomposition of the RoE into 3 different factors in the manner given below:

$$\text{ROE} = \underbrace{\frac{\text{Net Income}}{\text{Sales}}}_{1} \times \underbrace{\frac{\text{Sales}}{\text{Total Assets}}}_{2} \times \underbrace{\frac{\text{Total Assets}}{\text{Book value of shareholder's equity}}}_{3} \qquad \textbf{(Equation 3-2)}$$

If we look at the product of the first two terms in this decomposition (Equation 3-2), we start seeing the relationship between Return on Equity and Return on Asset. The product of the first two terms is nothing but the Return on Asset as shown by the following equation.

$$\text{ROA} = \frac{\text{Net Income}}{\text{Sales}} \times \frac{\text{Sales}}{\text{Total Assets}} = \frac{\text{Net Income}}{\text{Total Assets}} \quad \textbf{(Equation 3-3)}$$

$$\boxed{1} \qquad \boxed{2}$$

This allows us to view the Return on Equity (RoE) as:

$$\text{RoE} = \text{RoA} * \text{Capital Leverage} \qquad \qquad \textbf{(Equation 3-4)}$$

The third term of Equation 3-2 is also known as Capital Leverage, and is an indicator of the level of debt on the books of a company. This is purely a financial ratio and represents only the effects of the financial decisions made by a company. It does not have any relation to the operations of a company and therefore for the purposes of this project, we assume this to be a constant for ABC. With this fact in consideration, we selectively look at the first two terms of the Return on Assets decomposition and try to relate them to the operational decisions of a company.

3.2 DuPont Analysis: Return on Asset

The first term in Equation 3-2 is referred to as the Net Margin percentage. It is a function of the Gross Margin and the other fixed expenses of the company and is a key indicator of the profitability of a company. It is an indicator of the profit per dollar sale a company can book and is heavily dependent on the type of pricing power an industry and a company can command in a competitive environment. It is important to realize that ABC was able to have a significant advantage on pricing in the years prior to the economic slowdown of 2008. Post slow-down, the

industry became more competitive and price wars eroded the company's advantage on margins. (This is also a reason why ABC is looking at the second factor to improve its ROA and consequently the ROE) This leads ABC to look for other factors to improve its ROA.

Asset Turnover is another factor for overcoming the pressures on profitability due to competition or customer demand for lower prices (Timme & Timme, 2000).

Asset Turnover, also referred to as Velocity, is the second metric at the crux of this project. The Asset Turnover indicates the dollar amount of sales generated per dollar of asset. This metric assumes different importance in different industry settings. In service industries where typically the asset value is low, Asset Turnover might not be a very important factor; but in capital intensive industries, such as oilfield services, this metric is a key indicator of the efficiency of operations. It is thus a critical metric for ABC. The assets for ABC are the tools that it rents out to the various oil exploration companies; these assets generate returns for the company in the form of rental costs paid by the oil exploration companies to ABC.

It is important to note that the ROA is a product of Margin and Velocity. This means that a high margin product and a low margin product can have the same ROA if the high margin product has a lower velocity than the low margin product. This fact gives the key insight that the Margin is not the only lever to increase ROA. It can be increased through increasing Velocity in various forms in various businesses. For example, Dell used to maintain low inventories across its supply chain (thereby lowering its asset base) to maintain a high ROA in an environment where it did not necessarily have the highest margin (Biederman, 2006). A similar case of operational excellence is the retail giant Walmart which maintains the highest ROA within its industry

despite selling very low margin products (Biederman, 2006). In the case of ABC, it means that the Velocity and the ROA can be increased by generating higher sales volumes for a given fleet of tools.

One way ABC can increase Velocity, as mentioned earlier, is by managing its own logistics. This step will eliminate the various waiting times in the rental trip for each tool. As a consequence, each tool can have a lower cycle time, resulting in more rental trips for a given period of time. This in turn means that increased demand can be met from the same tool fleet.

Companies should move away from their Margin-only focus and instead pay due attention to ROA by also considering the effect of Velocity (Rothschild, 2006). Managing its own logistics may ABC help increase the Velocity and hence ROA but insourcing certain activities of logistics has other important implications. In order to make a rational decision, we must take a holistic approach to the question of managing own logistics by studying insourcing in general.

3.3   Insourcing and Vertical Integration

The dominant framework with which to evaluate strategic sourcing decisions is Michael Porter's *Competitive Strategy* (Porter, 1980). Porter's enumeration of the strategic benefits and costs of vertical integration starts with the *volume of services* to be performed by the integrated firm. Quite simply, if the volume of logistics services that can be accomplished by ABC's insourcing initiative is large enough to justify in-house effort, then the initiative would have merit.

A second strategic benefit is *economies of combined operations:* for example, in the context of ABC, insourcing logistics may have a synergistic effect not only on the delivery of tools to and from the maintenance base, but it may increase efficiency in loading operations at the dock. Another important benefit may be *economies of internal control and coordination*: insourcing the transportation function, for example, could easily enhance the coordination and scheduling of maintenance, since the company will have better visibility on tool arrival times. *Economies of information* are also quite possible—being a more active player in rig support transportation could result in better knowledge of key trends (such as local marine transport issues) that could have positive effects in other areas of the company.

Porter points out that through forward-integration a company such as ABC can achieve higher revenues through price discrimination. Not only could insourcing transportation allow ABC to charge a different price than its competitors, but it could also charge different prices depending on the rig's distance from port facilities. The optimization of price structures varies across geo-markets (and exceeds the scope of this paper), but insourcing logistics would clearly add leverage and value-added for ABC, serving as an additional source of product differentiation.

Porter's framework is fundamentally a cost-benefit analysis that exhaustively quantifies sourcing decisions, while also providing insights into those costs that cannot be easily quantified. One trend in the literature since his seminal work has been to expand his analysis to include the pre-transactional and post-transactional costs that more comprehensively capture the total costs of a purchasing decision. The Total Cost of Ownership (TCO) model accounts for such things as the labor cost of thinking about logistics solutions, of creating and soliciting requests for bids, and fallout from a failed service (Ellram, 1993). Reverse logistics, a relatively new concept in the

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1990s, is in fact an example of a post-transactional cost that is captured and explained by the TCO model (Tibben-Lembke, 1998). The TCO framework has had a profound effect on the outsourcing literature since the mid-1990s.

Maltz and Ellram expand the TCO model even further to include the hidden costs of critical logistics relationships; their analysis is known as Total Cost of Relationship (TCR) model (Maltz, 1997). By insourcing, ABC would be assuming responsibility for the interactions between themselves and their chosen 3PL logistics provider, and between the provider and the customer. The management of the 3PL relationship is not insignificant; in addition to the straightforward purchasing and legal costs of contracting, the company will also expend considerable resources ensuring the quality of the logistics service for which they will now be responsible. Monitoring service levels, dealing with episodic shipment failures, reacting to unforeseen transportation requirements, establishing channels for customer feedback on logistics, and maintaining historical service records are all costs that go beyond the sticker price of insourcing. For example, how their chosen provider deals with the client now becomes a direct reflection on ABC – a consideration that ABC heretofore has not had to deal with. So in addition to the quantifiable transaction costs of insourcing, ABC must consider the Total Cost of Relationship (TCR) as a key component of their insourcing decision.

Additionally, these changing external relationship costs will be accompanied by evolving relationship costs internal to the company as well. In particular, the relationship between logistics and sales and marketing (S&M) will become even more important as logistics practitioners assume greater role in customer interaction (Daugherty, 2009). Currently, S&M manages customer demand and passes along service requirements to the ABC logistics and

operations teams, who fulfill the demand by producing and delivering customized tools to a 3PL

provider of the client's choosing. By insourcing, the internal logistics and operations team not

only assumes a customer-facing role with clear S&M implications, but also becomes the

producer of valuable logistics information (such as choice of 3PL provider and costs of required

service levels) that become key components in the day-to-day negotiation with the customer that

is the bread and butter of S&M. On a strategic level, the success of the insourcing initiative may

well rest on the nexus between logistics and S&M, since communicating the benefits of the

logistics partnership to the customer will largely be accomplished by S&M (Maltz, 1997). In

short, what has traditionally been a predominantly one-way relationship will by necessity evolve

into a more equal relationship, with vital inputs flowing in both directions between S&M and

logistics. The internal dynamics of the company are an important part of the insourcing decision

that is often overlooked.

Of course, these new relationships are an opportunity as well. Porter points to the *economies of*

stable relationships as a way that companies can generate long-term value from the insourcing

initiative. Benefits will accrue, for example, between ABC and their customers if the insourced

logistics service is seen as a source of product differentiation between how ABC treats its

customers and how its competition does (Porter, 1980). As with all of these potential strategic

benefits, the actual benefits would depend on how the proposed initiative was executed on a

sustained basis.

As a result of insourcing, the *enhanced ability to differentiate* has other implications for ABC. In

addition to an enhanced customer experience, it would allow ABC to drive additional savings out

of their tool fleet, with long-term benefit to both ABC and their customers. Quantifying this potential benefit is one of the goals of this thesis.

A vital component of the insourcing decision that is related to the ability to differentiate is the access to additional capacity that it allows (Kenyon, 2011). In the case of ABC, this additional capacity is represented by the increased asset velocity resulting from insourcing; that is, the more jobs that can be serviced with the same size tool inventory if they were to streamline the transportation function. Not only does the existing tool inventory service more jobs, but by doing so, it obviates the need to purchase additional tools. This additional capacity could also lead to increased market coverage for ABC, since they will be in a position to serve more clients than they otherwise would have.

The potential strategic benefits of logistics insourcing are balanced by the potential costs, the most obvious of which is overcoming *mobility barriers* into an adjacent business (Porter, 1980). The capital costs of truly insourcing logistics (buying boats and hiring ship captains and crews) is likely prohibitive; but even an insourced 3PL solution – with minimal capital costs -- will be challenged to overcome the economies of scale that the rig operator currently achieves by shipping full boatloads of tools on timelines favorable to the client. Even if ABC was able to pass along some of the transportation costs to its clients, it is doubtful that the pass-thru mark-up would – by itself – be competitive with the fractional cost the client is now paying for full boatloads of tools.

Another risk of insourcing logistics is increased *exposure to market developments*; if the market experiences a downturn, for example, or the price of boat fuel suddenly increases, the integrated

company would be at a loss. However, these losses would be mitigated if the 'insourced' solution was a 3PL; and if the market experienced a significant downturn (as in 2007-08), the cost of ballooning fuel charges for a leased boat would probably be negligible compared to other revenue decreases. Mello highlights the fact that if the insourcing project fails, the company will have broken (or at least significantly altered) old relationships, and will spend considerable time and effort rebuilding them in order to get their product to market (Mello, 2008). In short, changing the logistics status quo adds a level of risk that must now be managed.

Despite the risks of switching from an outsourced logistics solution to an insourced solution, the literature provides many examples of successful companies doing just that. Kimberly-Clark, the $2.6 billion paper manufacturer, decided to bring their European transportation business back in-house in 2009 in order to drive further savings from their supply chain. In addition to controlling costs, Kimberly Clark also cited the increased control over the environmental impact caused by their supply chain as a reason to insource (*Supply Chain Europe Magazine*, 2009).

In addition to environmental and short-term cost considerations, other companies insource their logistics management in order to foster long-term relationships with carriers. Owens-Corning, the Ohio-based glass manufacturer, keeps its $400 million domestic transportation operation in-house, and cites the synergy that comes from stable long-term relationships with transportation providers (Biederman, 2006). On the other hand, Dell's decision to insource over 1000 logistics positions at an Ohio distribution center was made based on that facility's unique situation – and was not constrained by a one-size-fits-all approach to logistics sourcing. This example illustrates that insourcing may be appropriate for one part of a company, but not for others (Biederman, 2006).

4 Methodology

The financial impact of the logistics insourcing decision needs to be studied and compared to the decision of maintaining status quo by measuring the Return on Asset (ROA) in each of the scenarios. The calculation of ROA in turn involves the calculation of Net Income and Asset Size for each scenario. The Net Income can be estimated by calculating the Revenues and Costs associated with each scenario. The Asset Size depends on the level of demand which is required to be met and the time durations for which the tool is busy. Therefore, by estimation of the individual components in the ROA relation we can be in a position to compare the status quo and insourcing scenario.

4.1 Scenarios Considered

In the modeling of ROA, there were three models considered:

- o Scenario #1: It is the current demand level with no insourcing. This is a version of Status Quo at the current demand level. This scenario can be considered as a baseline scenario and will be referred to as 'Status Quo' scenario hereafter. The purpose of this scenario is to validate the various estimates used in the model against the actual observed values.

- o Scenario #2: The insourcing scenario at a future demand level. This scenario will be referred to as the 'Insourcing' scenario hereafter.

- Scenario #3: It is the future demand level with no insourcing. This is a version of Status Quo but at the future demand level. Please note that the future demand level considered in this scenario is the same as that in the Scenario 2. This scenario will be referred to as 'Scenario #3" hereafter.
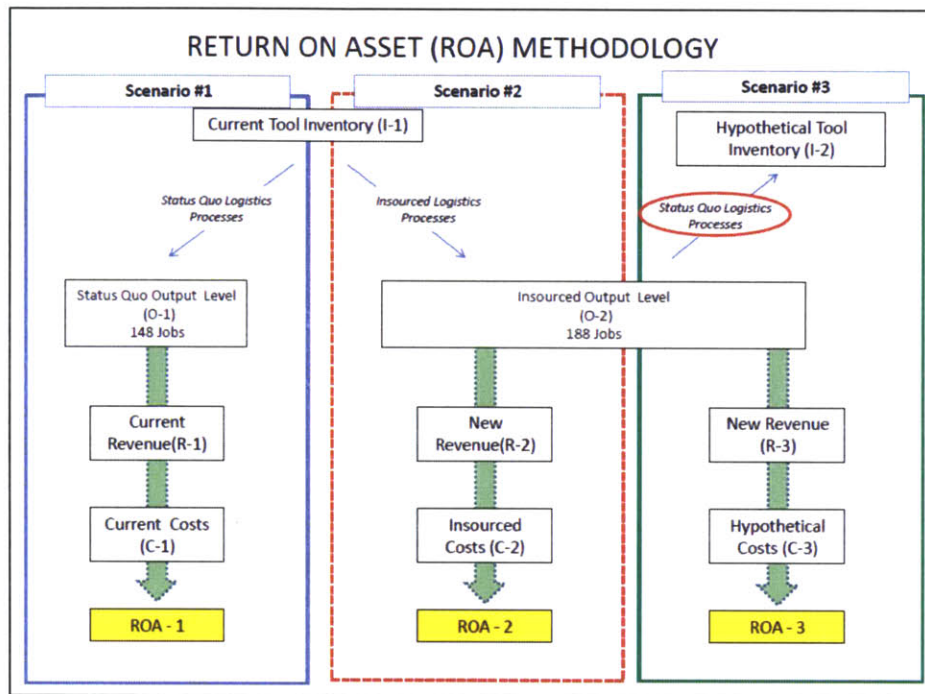
Figure 4-1 ROA Scenario Descriptions

4.2   Overall description of methodology

The following 6 step methodology, as displayed in Figure 4-2, is proposed to evaluate the options.
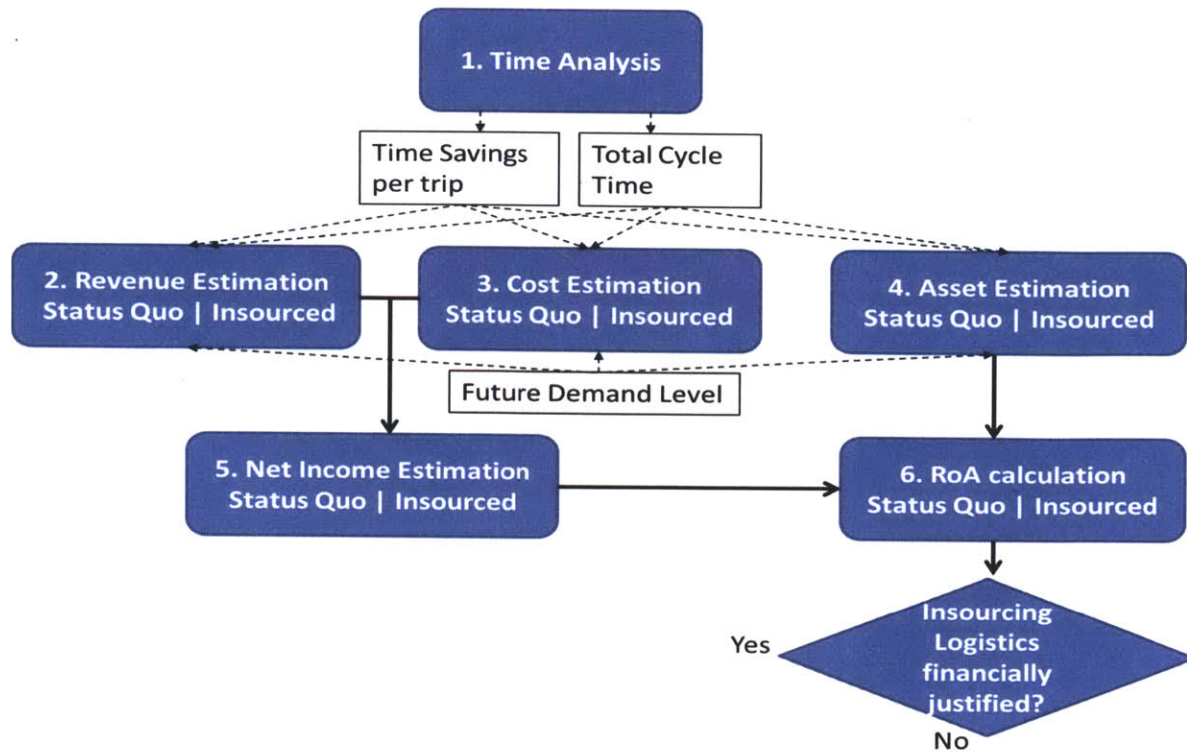
Figure 4-2 Proposed steps to compare financial impacts of insourcing vs status quo

The 6 steps taken to evaluate the options are indicated below. Each step can be considered as a sub-model and hence the nomenclature in the brackets.

1. Time Analysis (referred to as 'Time Model' hereafter)

2. Revenue Estimation (referred to as 'Revenue Model' hereafter)

3. Cost Estimation (referred to as 'Cost Model' hereafter)

4. Asset Estimation (referred to as 'Asset Model' hereafter)

5. Net Income Estimation

6. Return on Asset calculation

The following sections will take up each step and discuss the Purpose, Inputs, Steps & Outputs for each step in the sequence mentioned above. Following the step description, we have a short discussion on future demand level to clearly state the assumption on future demand level.

4.2.1 Time Model

4.2.1.1 *Purpose*

The objective of this analysis is to estimate the time savings in tool rental trip time through insourcing logistics and estimate the end-to-end cycle time for all tools. Also, certain basic analysis is performed to investigate the relationship between tool rental trip times and rig locations or tool types. However, it must be remembered that the variability analysis of tool rental trip time is not the core aspect being examined in the thesis.

4.2.1.2 *Input*

1. Detailed Trip rental time data containing various transportation and activity times for each part of the journey.

2. Separate maintenance logs for Green and Red tools.

3. Operational alternatives such as every day shipment, once a week shipment, twice a week shipment etc.

4.2.1.3 *Steps*

1. The expected value of the total trip rental time was considered from the detailed trip rental time data.

2. Maintenance times for Red and Green tools were separately considered from the maintenance logs at the tool base.

3. The detailed trip rental time was considered and the data for Storage After Run time was extracted. The logic behind this step is that it is only the Storage After Run time which can be reduced by managing the return logistics of the return journey. The expected value of the Storage After Run represents the total quantum of time savings possible in the rental trip.

4. The operational alternative (every-day shipping, once a week shipment and twice a week shipment) was considered to estimate the percentage of the total quantum of savings that can be actually saved.

4.2.1.4 *Outputs*

1. Total Cycle Time
2. Expected Time Savings Per Trip

4.2.2 Revenue Model

4.2.2.1 *Purpose*

This value is pivotal to Net Income calculation which is used in ROA calculation.

4.2.2.2 *Input*

1. Number of tools currently in the inventory for each tool family

2. Total number of days in a year

3. Estimated End-to-End cycle time for Red tool

4. Estimated End-to-End cycle time for Green tool

5. Estimated BRT time for the tool

6. Estimated Rental Trip time for the tool

7. Typical Red to Green tool proportion in a tool basket

8. Standby charge per tool per day

9. Operating charge per tool per day

4.2.2.3 *Steps*

1. Total Tool Days Available for tool family calculation

   *Total Tool Days Available for tool family = Number of tools currently in the inventory *

   364.8   **Equation (4-1)**

2. Expected tool days spent on each trip by a typical tool set calculation

   *Expected tool days spent on each trip = 1 *(Estimated End-to-End cycle time for Red*

   tool) + 2 (Estimated End-to-End cycle time for Green tool)*   **Equation (4-2)**

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The assumption here is that each tool set consists of 1 tool which will be Red and the other two will act as backup or Green tools.

3. Maximum Trips Achievable by entire tool family calculation

   Maximum Trips Achievable by entire tool family = Total Tool Days Available for tool family / Expected tool days spent on each trip   **Equation (4-3)**

4. Expected Revenue per trip calculation

   *Expected Revenue per trip = Standby charge per tool per day * (Estimated Rental Trip time for the tool - Estimated BRT time for the tool) + Operating charge per tool per day* Estimated BRT time for the tool*   **Equation (4-4)**

5. Total Annual Revenue calculation

   *Total Annual Revenue calculation = Maximum Trips Achievable by entire tool family *Expected Revenue per trip*   **Equation (4-5)**

4.2.2.4   *Output*

Expected Annual Revenue

4.2.3   Cost Estimation

4.2.3.1   *Purpose*

The objective is to identify only relevant costs and model them. By relevant costs, we mean those costs which change with or without insourcing. Our findings show that the following are the relevant costs for ABC pertaining to the decision of insourcing –

1) Licensing Fees

2) Boat rental costs

3) Fuel costs for the rental boat

4) Dock space monthly charge

5) Dock loading/unloading costs

6) Truck transportation costs from dock to base

7) Other miscellaneous costs such as lubricants etc.

All the costs can be classified into 3 types –

- Fixed costs (Monthly Charges)

- Mileage based costs

- Per Trip costs

Given the classification of costs, we now have a simple framework to calculate costs which can be applied as explained in the following sub-sections.

4.2.3.2 *Inputs*

1. Maximum number of trips achievable across all tool families

2. Various types of relevant costs

3. Utilization factor of boat

4. Average distance travelled per trip

5. Operational Policy based on which the Estimated Time Savings per trip have been calculated

4.2.3.3 *Steps*

1. Number of boats required calculation

   Number of boats required = (Average Time per Trip * Maximum number of trips achievable across all tool families) / (365 * Utilization factor of boat) **Equation (4-6)**

   The value through this equation will be rounded up to arrive at the number of boats required. The operational policy assumed in this case is where the boat will anticipate a tool "tripping out" from BRT and coordinate its schedule to be available just in time for the pick-up.

2. Annual fixed cost Calculation

   Annual Fixed cost = Annual Boat Rental costs + Annual Other Fixed costs

   Annual Boat Rental costs = Number of boats required * Cost per month per boat *12

   Annual Other Fixed costs = 12* Monthly costs   **Equation (4-7)**

   The other fixed costs primarily include the dock space charges.

3. Annual costs for the per trip type costs calculation

Annual costs for the per trip type costs = Number of Trips achieved * Total cost per trip (of per trip type costs) **Equation (4-8)**

The per trip type costs include dock loading and unloading charges and the truck transportation costs from the dock to the rig.

4. Annual costs for the mileage type costs calculation

Annual costs for the mileage type costs = Per mile fuel cost * Maximum number of trips achievable across all tool families * Average distance travelled per trip **Equation (4-9)**

5. Total Annual Cost calculation

Total Annual Cost = Annual Fixed cost + Annual costs for the per trip type costs + Annual costs for the mileage type costs **Equation (4-10)**

4.2.3.4 *Output*

1. Expected Annual Cost

4.2.4 Asset Estimation

4.2.4.1 *Purpose*

This step is only involved in Scenario 3 where the future demand level is considered in terms of the maximum number of trips achievable with no insourcing. In this case, additional number of tools is required to serve the increase demand.

4.2.4.2 *Steps*

1. Using Equation 4-1 the number of tools required for each tool family calculate using the following two relationships derived from:

   Total Tool Days Available for tool family = Maximum Trips Achievable by entire tool family * Expected tool days spent on each trip   **Equation (4-11)**

   Number of tools currently in the inventory = Total Tool Days Available for tool family / 364   **Equation (4-12)**

4.2.4.3 *Output*

1. Number of tools required in the inventory

4.2.5   Net Income Calculation

4.2.5.1   *Purpose*

The net income forms the numerator part of the Return on Asset equation, and its calculation involves as the Revenue estimate and Cost estimate as two of the inputs.

4.2.5.2   *Inputs*

1. Revenue estimate

2. Cost estimate for the relevant costs

3. Other historic non-service revenues (where service revenue refers to the revenue generated only from the rental trips through operating and standby charges)

4. Other historic costs (non-relevant, are not affected by insourcing)

4.2.5.3   *Steps*

1. Calculation of historic averages of total revenue as a percentage of service revenue

    The Service revenue is the revenue generated through the business of renting out tools to various rigs. In our case, it is the service revenue which is being estimated in the Revenue Model. There are other types of revenue which are realized through tool book value reimbursement when a client loses a tool. The logic for estimation of Total Revenue in

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the future is the assumption that it will be most likely equal to a given percentage of service revenue (where this percentage will be greater than 100%).

The historical fractions of the quantity (Total Revenue / Service Revenue) are considered from the given data and the average of the same quantity across various periods is calculated.

2. Calculation of historic averages of costs as a percentage of total revenue

The various non-relevant costs are considered. The percentage of these costs as a percentage of total revenue is considered. Thereafter, the historical average of these percentages is calculated. The non-relevant costs can be seen in the table

3. Calculation of Net Income

The Net Income calculation can be clearly seen in the following table (Table 4-1),

Table 4-1 Steps to calculate Net Income

	Revenue / Cost Type	Netting of Sign	Calculation Assumption
	Service Revenue		
	Total Revenue	+	Calculated as a historical percentage of service revenue
	Transportation Cost	-	
	Direct Field Cost	-	
Non relevant costs	Other Field Cost	-	Calculated as a historical percentage of total revenue
	Selling General & Administration (SG&A) also including R&E	-	
	Operating Earnings (EBIDTA)		
	Depreciation	-	Calculated as a historical percentage of total revenue
	EBIT		
			Calculated as a historical percentage of EBIT
	Tax	-	
	Net Income		

4.2.5.4   *Outputs*

1. Net Income

4.2.6   **Return on Asset Calculation**

4.2.6.1   *Purpose*

The ROA calculation is the final step to make the financial comparisons between scenarios.

4.2.6.2   *Inputs*

1. Gross Book Value of Tools at time of purchase (Price of tools)

2. Average life of existing tools in months

3. Existing tool inventory

4. Number of tools considered in the inventory of the tool family

5. Net Income

4.2.6.3 *Steps*

1. Valuation of tools considered in the inventory

Value of 1 tool = Price of tool – (Average life of tool in months/ 48 * Price of new tool)

Equation (4-13)

Total Value of tools in the tool family = Number of tools considered in the inventory of the tool family * Current Value of 1 tool   **Equation (4-14)**

Total Value of tools = $\sum$ (Total Value of tools in the tool family) across all tool families   **Equation (4-15)**

2. ROA calculation

ROA = Net Income / Total Value of tools   **Equation (4-16)**

4.2.6.4 *Outputs*

Return on Asset

5 Results and Analysis

5.1 Time Model

5.1.1 Estimating End-to-End cycle time

It can be clearly seen in Fig. 2-1 and Equation 2-3 that the number of times a particular tool can be used in a given period of time actually depends on the sum of Rental Trip time Turn Around Time (TAT) in the tool base (maintenance time). We are calling this sum of Rental Trip time and TAT as End-to-End cycle time. This time represents the typical duration between one Green state of a tool to the next Green state of the same tool. Thus the End-to-End cycle time is the summation of 2 components –

1. Rental Trip Time

2. Maintenance Time (also referred to as Turn Around Time (TAT))

The figure below (Fig.5-1) clearly depicts the schema for the Time Analysis.
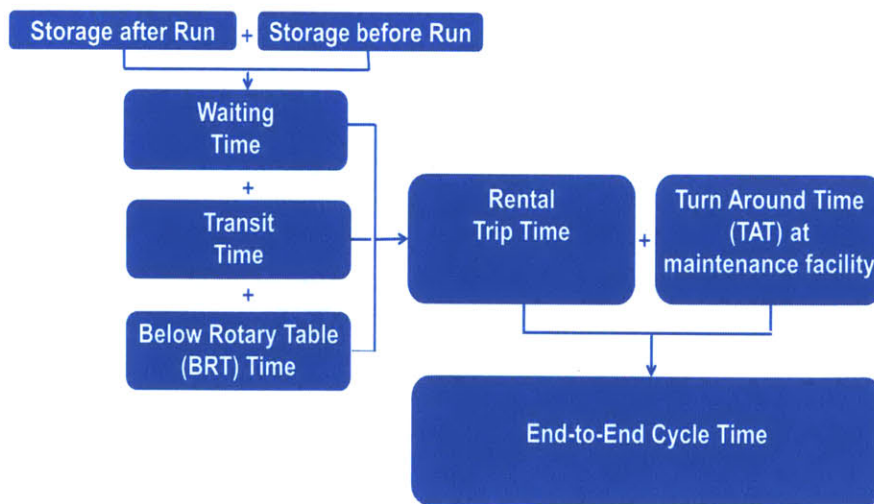
Figure 5-1 Schema for calculation of end-to-end cycle time

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5.1.1.1 *Calculation of Rental Trip time and its components*

5.1.1.1.1 Methodology of Rental Trip time analysis

5.1.1.1.1.1 GPS data collection

ABC installed Global Positioning System (GPS) tracking devices on tool baskets in the Gulf of
Mexico over the course of 9 months in 2010; the resulting data consist of over a hundred
observations of tool-carrying baskets as they were transported by truck from the Louisiana
maintenance base to a port on the Gulf of Mexico, cross-loaded onto boats, and delivered to off-
shore oil rigs. The GPS devices provide time snapshots of each leg of the journey, to include the
Wait Time on the rig, and the return trip back to the base.

A set of detailed rental trip data was constructed using Global Positioning Technology (GPS)
data. Typically tools are carried in silos known as tool baskets on any rental trip. ABC attached
GPS tracking devices to some tool baskets to gather the space-time profile of trip. This data was
instrumental in gathering micro level data about waiting times at each stage of the trip as well as
the transportation time between the stages. Further, this data was combined with the usage log of
data at the rig to capture the complete profile of a trip.

The difference between times at various points yielded periods of waiting times at different
stages of the trip and the transportation times between stages. Thereafter, the following steps
were undertaken to cleanse the data –

1. Only trips with complete profiles were considered

2. Unique trips were identified based on the same exit dates from the base and entrance dates to the base

3. There were certain outliers where the tool waited at the rig for more than 30 days before being shipped back to the tool base. ABC Management indicated that such cases were not representative of the actual operations.

In total, 54 unique and complete trips were captured with this data. Each trip consisted of one or more tools being carried to the rig and returned. This sample consisted of trips to 12 different Rig locations.

5.1.1.1.2   Broad analysis of Rental Trip time

The GPS data set enables us to get an idea of the average time spent in each leg of the rental trip journey. The following table (Table. 5-1) shows the breakdown of average percentages of times spent in each stage.

Table 5-1 Breakdown of rental trip

Activity Time	Calculated as	Percentage of Total Rental Trip Time
Time to Dock	Enter Time at Dock – Exit Time from Base	1.3%
Time at Dock	Exit Time from Dock – Enter Time at Dock	3.6%
Dock to Rig	Enter Time at Rig – Exit Time From Dock	2.6%
Total Time to Rig		**7.6%**
Storage before Run	Start Time of Usage – Enter Time at Rig	34.8%
BRT Time	End Time of Usage – Start Time of Usage	29.0%
Storage after Run	Exit Time from Rig – End Time of Usage	15.5%
Total Rig Time		**79.3%**
Rig to Dock	Enter Time at Dock (return) – Exit Time from Rig	3.3%
Time at dock	Exit Time at Dock (return) – Enter Time at Dock (return)	2.0%
Dock to Base	Enter time at base (return) – Exit Time at Dock (return)	1.3%
Total Time to Base		**6.6%**

The table helps highlight the fact that only about 29% of the rental trip time is spent on actual usage of the tool. The majority of time (50% of the rental trip time) is spent in waiting times at the rig.

5.1.1.1.3   Overall Rental Trip Time sample analysis

Rental Time Bucket (in days)	Number of Observations	Percentage
<2.5	0	0%
2.5-7.5	2	4%
7.5-12.5	7	13%
12.5-17.5	10	19%
17.5-22.5	9	17%
22.5-27.5	11	20%
27.5-32.5	9	17%
>32.5	6	11%
Total	54	100%
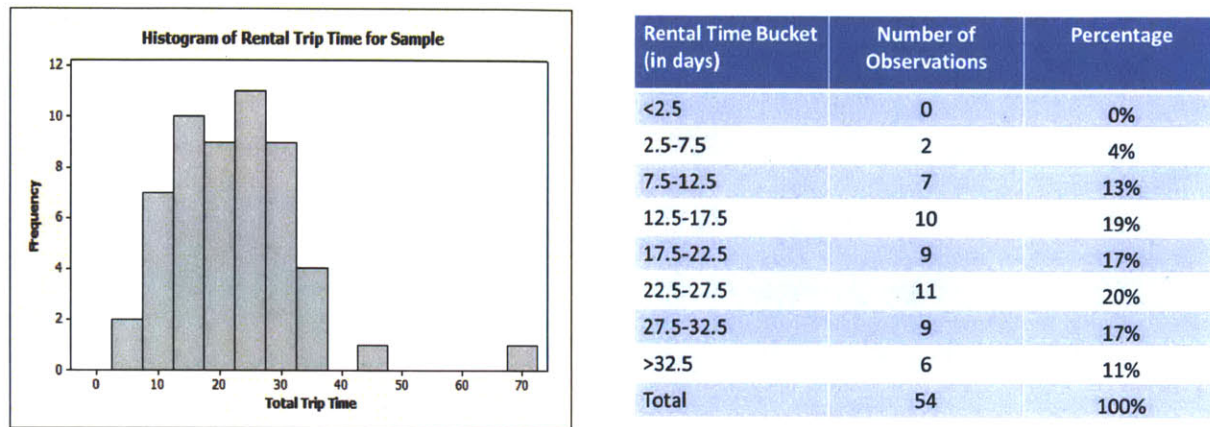
Figure 5-2 Histogram of Rental Trip Time, with frequency matrix

The rental trip times in the sample are concentrated between 17.5 to 32.5 days comprising 54% of the observed data. The overall sample statistics are displayed in the following table.

Table 5-2 Descriptive statistics for rental trip time

Rental Trip Time Sample Statistics (in days)	
Mean	22.6
Standard Error of Mean	1.5
Standard Deviation	11.1
Minimum	5.4
First Quartile	14.5
Median	21.0
Third Quartile	28.6
Maximum	71.0

5.1.1.1.4   Analysis of components of Rental Trip Time

5.1.1.1.4.1   Waiting Time component: Storage Before Run

The waiting time of tool at rig after usage represents the largest time consuming activity in the entire rental trip. The observations have been described in Table 5-3.

Table 5-3 Descriptive statistics for Storage before Run

Storage before Run time Sample Statistics (in days)	
Mean	8.41
Standard Error of Mean	0.856
Standard Deviation	6.23
Minimum	0.26
First Quartile	2.58
Median	7.36
Third Quartile	11.92
Maximum	22.49

5.1.1.1.4.2   Waiting Time component: Storage After Run

The waiting time of tool at rig after usage represents the third largest time consuming activity in the entire rental trip. The observations can be represented in a histogram as shown in Fig. 5-3.

Storage after Run Bucket (in days)	Number of Observations	Percentage
<0.5	4	7%
0.5-1.5	14	26%
1.5-2.5	7	13%
2.5-3.5	6	11%
3.5-4.5	7	13%
4.5-5.5	3	6%
5.5-6.5	4	7%
>6.5	9	17%
Total	54	100%
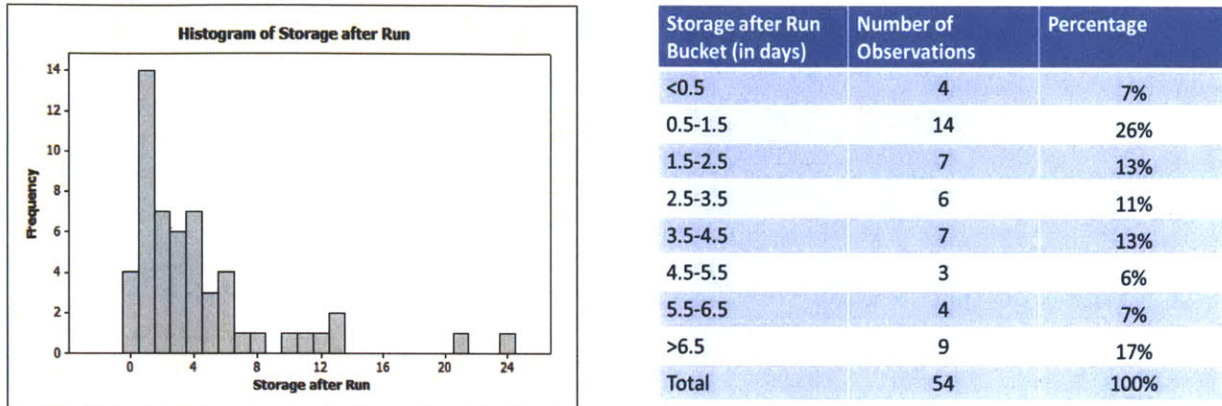
Figure 5-3 Histogram of Storage After Run, with frequency matrix

It can be seen from Fig.10 that 43% of the observations exceed 3.5 days. (You may add the statement around 3.5 days once discussed). The following table displays the sample statistics for the Storage after run times.

Table 5-4 Descriptive statistics for storage after run

Storage after Run time Sample Statistics (in days)	
Mean	4.3
Standard Error of Mean	0.65
Standard Deviation	4.8
Minimum	0.45
First Quartile	1.07
Median	3.09
Third Quartile	5.03
Maximum	23.57

Therefore, based on the observations above it can be inferred that on an average 4.3 days can be saved in Rental Trip time, if theoretically tools were picked up as soon as their usage was over.

5.1.1.1.4.3   Transit Time

Transit time is composed of 6 elements under 2 headings as displayed in the following table –

Table 5-5 Composition of Transit Time

Activity Time	Calculated as
Time to Dock	Enter Time at Dock – Exit Time from Base
Time at Dock	Exit Time from Dock – Enter Time at Dock
Dock to Rig	Enter Time at Rig – Exit Time From Dock
Total Time to Rig	
Rig to Dock	Enter Time at Dock (return) – Exit Time from Rig
Time at dock	Exit Time at Dock (return) – Enter Time at Dock (return)
Dock to Base	Enter time at base (return) – Exit Time at Dock (return)
Total Time to Base	

As expected, the transit times display multi-modality as shown in Fig. 5-4.
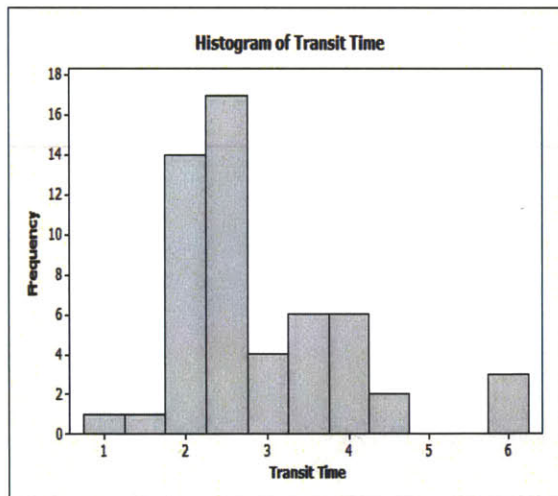
Transit time Sample Statistics (in days)	
Mean	2.91
Standard Error of Mean	0.15
Standard Deviation	1.07
Minimum	1.18
First Quartile	2.14
Median	2.53
Third Quartile	3.50
Maximum	6.07

Figure 5-4 Histogram of Transit Time, with frequency matrix (days)

The variability is majorly across rig locations while there is minimum variability within each rig location as shown in the following table –

Table 5-6 Variability of Transit Time (within/overall)

Rig	Average of Transit Time	StdDev of Transit Time
Rig 1	1.97	0.29
Rig 2	3.41	0.96
Rig 3	2.74	0.75
Rig 4	3.34	0.25
Rig 5	2.48	0.24
Rig 6	2.24	-
Rig 7	2.63	0.25
Rig 8	2.70	0.43
Rig 9	1.59	-
Rig 10	1.93	-
Rig 11	3.53	0.16
Rig 12	6.01	0.05
Total	2.91	1.07

5.1.1.1.4.4 BRT Time

These times also display multi-modality (Fig.5-5) and the variance may be due to their dependence on rig and tools.
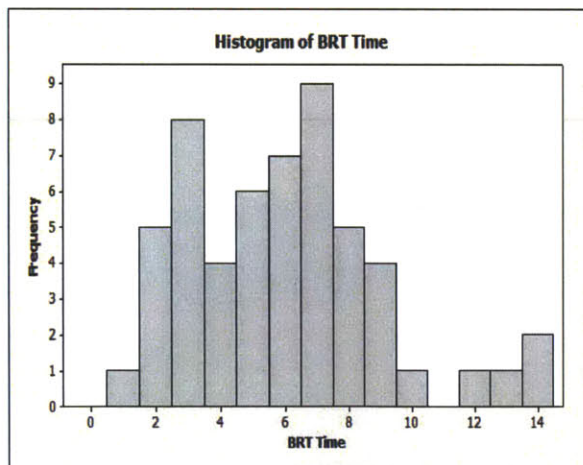
BRT time Sample Statistics (in days)	
Mean	6.04
Standard Error of Mean	0.43
Standard Deviation	3.17
Minimum	1.42
First Quartile	3.25
Median	5.80
Third Quartile	8.30
Maximum	14.19

Figure 5-5 Histogram of BRT Times, with frequency matrix

The relation of BRT to the rig location can be seen in the table while the relationship with tool type will we explored in the following section.

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5.1.1.1.5   Summary results from rental trip time sample analysis

Table 5-7 Expected values for various waiting and activity times

Time Bucket	Average Value
Waiting Time (Storage after Run + Storage before Run)	12.71
Transit Time	2.91
BRT Time	6.04
Total Rental Trip Time	21.6

5.1.1.2   *Generalization of findings*

Based on the sample, we can now infer that in a typical rental trip of duration of 21.6. Since these findings are from a sample, we must investigate whether these findings can be extended to all kinds of customer locations and tool types. Specifically, we investigated the variability of the major legs of rental trip (Storage before run, BRT and Storage after run) with respect to rigs and tool types.

5.1.1.2.1   Generalization of findings: Methodology

One stage ANOVA (Analysis of Variance) of analyzed time duration (e.g. Storage before run) has been done with respect to Rig location and Tool Type. The analysis is done in MINITAB 15.0 software (student trial version for 30 days). A P- Value of less than 0.05 indicates that there is a significant relation between the two variables (e.g. time duration and rig) and else there is no significant relation between the two variables and may be considered independent.

5.1.1.2.1.1   Storage before run analysis

5.1.1.2.1.1.1   Relationship between Storage before run and Rig location

```
One-way ANOVA: Storage before Run versus Rig Code

Source    DF     SS    MS      F      P
Rig Code  11  1089.1  99.0  1.23  0.296
Error     42  3368.7  80.2
Total     53  4457.8

S = 8.956   R-Sq = 24.43%   R-Sq(adj) = 4.64%

                               Individual 95% CIs For Mean Based on
                               Pooled StDev
Level   N    Mean    StDev   -+---------+---------+---------+--------
1      11   5.466    4.593            (---*--)
2      10   6.036    3.537            (---*---)
3       4   9.771    5.979            (------*-----)
4       3   7.614    6.919          (------*------)
5       2   8.006    7.337         (------*--------)
6       1   2.691      *      (----------*----------)
7       5  10.852    8.852             (----*-----)
8       9  13.170   17.539               (---*---)
9       1   2.161      *      (-----------*---------)
10      1  20.104      *            (----------*----------)
11      4  19.905    1.949             (-----*-----)
12      3   9.382    1.120          (-----*-----)
                               -+---------+---------+---------+--------
                              -15        0        15       30

Pooled StDev = 8.956
```


Figure 5-6 ANOVA analysis and scatterplot of Storage Before Run vs Coded Rig Locations

The P-Value in the Fig. 5-6 shows that there is no dependency of storage and the rig location.

5.1.1.2.1.1.2   Relationship between Storage before run and Tool Code

```
One-way ANOVA: Storage before Run versus Tool Code

Source     DF     SS     MS      F      P
Tool Code   4   435.8  108.9  1.50  0.213
Error      71  5170.0   72.8
Total      75  5605.8

S = 8.533   R-Sq = 7.77%   R-Sq(adj) = 2.58%

                               Individual 95% CIs For Mean Based on
                               Pooled StDev
Level   N    Mean    StDev   -+---------+---------+---------+--------
1       9   4.983    5.683   (----------*----------)
2      29   8.358    6.664          (------*-----)
3      18  12.780   12.663              (-------*-------)
4       8   9.507    8.912        (------------*-----------)
5      12   7.727    5.927        (--------*---------)
                               -+---------+---------+---------+--------
                              0.0       5.0      10.0      15.0

Pooled StDev = 8.533
```


Figure 5-7 ANOVA analysis and scatterplot of Storage Before Run vs. Tool Code

The P-Value in the Figure 5-7 indicates that there is no dependency of storage before run on the type of tool.

5.1.1.2.1.2 BRT Time analysis

5.1.1.2.1.2.1   Relationship between BRT time and Rig location

```
One-way ANOVA: BRT Time versus Rig

Source  DF     SS    MS      F      P
Rig     11  234.34  21.30  3.01  0.005
Error   42  297.62   7.09
Total   53  531.96

S = 2.662   R-Sq = 44.05%   R-Sq(adj) = 29.40%

                             Individual 95% CIs For Mean Based on
                             Pooled StDev
Level    N    Mean   StDev  ------+---------+---------+---------+---
Rig 1   11   4.958   2.424              (--*--)
Rig 10   1   7.063     *          (-----------*----------)
Rig 11   4   6.220   4.228           (----*-----)
Rig 12   3  11.231   5.133                    (-----*------)
Rig 2   10   4.727   1.819             (--*---)
Rig 3    4   2.821   1.746     (-----*----)
Rig 4    3   5.775   1.054          (------*-----)
Rig 5    2   9.625   1.149                  (------*-------)
Rig 6    1   5.788     *       (----------*---------)
Rig 7    5   8.908   2.805                 (----*----)
Rig 8    9   6.416   2.707            (---*--)
Rig 9    1   2.521     *     (-----------*---------)
                            ------+---------+---------+---------+---
                              0.0       5.0      10.0      15.0

Pooled StDev = 2.662
```


Figure 5-8 ANOVA analysis and scatterplot of BRT Time vs. Rig Code

The P-Value in the Fig.5-8 indicates that there is dependency of BRT time on the type of tool.

5.1.1.2.1.2.2   Relationship between BRT time and Tool Type

```
One-way ANOVA: BRT Time versus Tool Code

Source      DF    SS    MS     F      P
Tool Code    4   27.3   6.8  0.60  0.667
Error       79  904.6  11.5
Total       83  931.9

S = 3.384   R-Sq = 2.93%   R-Sq(adj) = 0.00%

                              Individual 95% CIs For Mean Based on
                              Pooled StDev
Level   N   Mean   StDev  ---+---------+---------+---------+------
1      10  6.497   3.327  (--------------*--------------)
2      31  5.996   3.355      (------*-------)
3      23  6.298   3.888       (-------*--------)
4       8  8.051   3.036            (--------------*--------------)
5      12  6.286   2.528      (----------*----------)
                          ---+---------+---------+---------+------
                           4.8       6.4       8.0       9.6

Pooled StDev = 3.384
```


Figure 5-9 ANOVA analysis and scatterplot of BRT Time vs. Tool Code

The P-Value in the Fig. 5-9 indicates that there is no dependency of BRT time on the type of tool.

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5.1.1.2.1.3 Storage after Run Time analysis

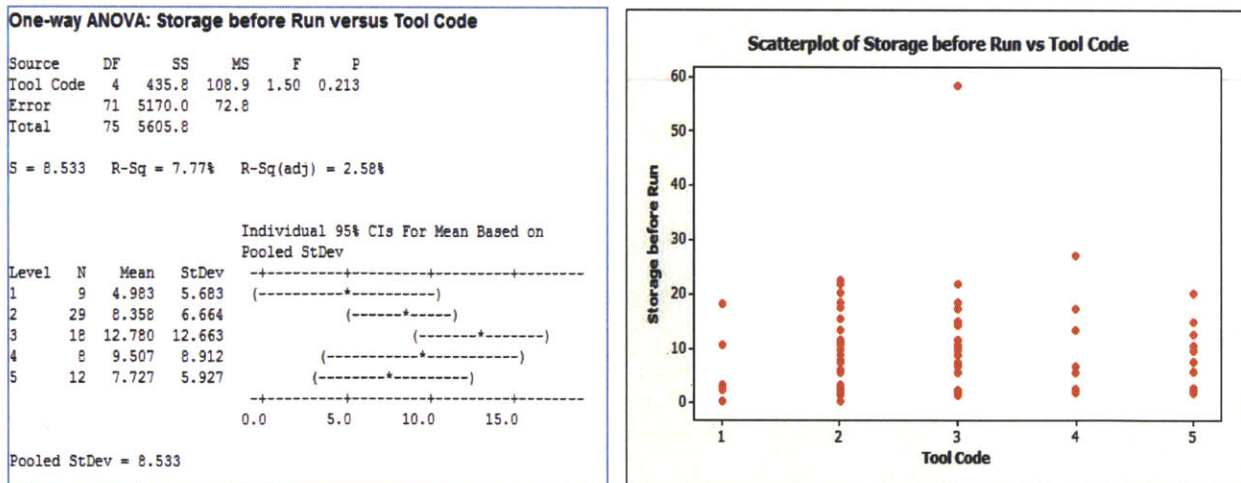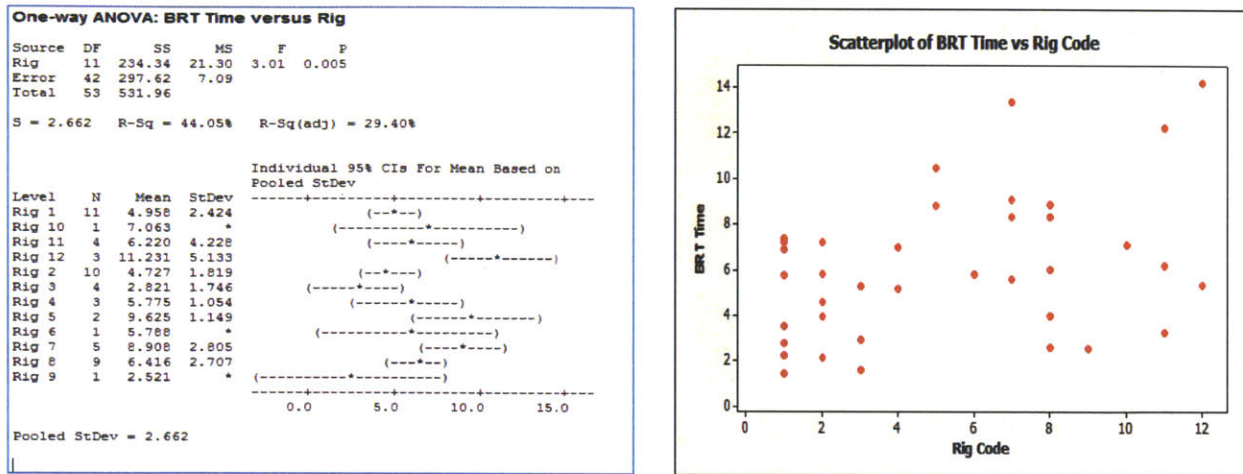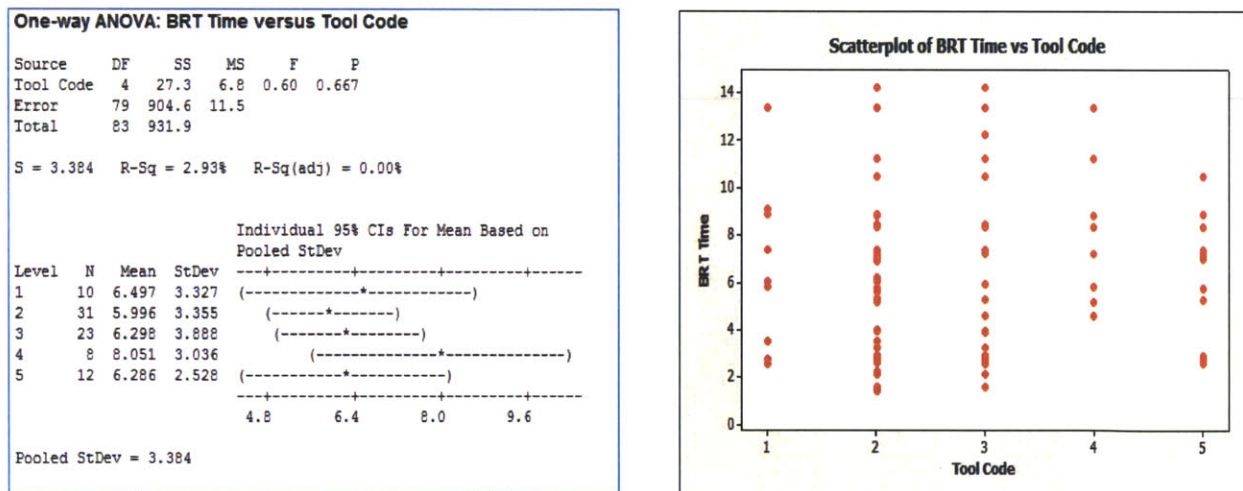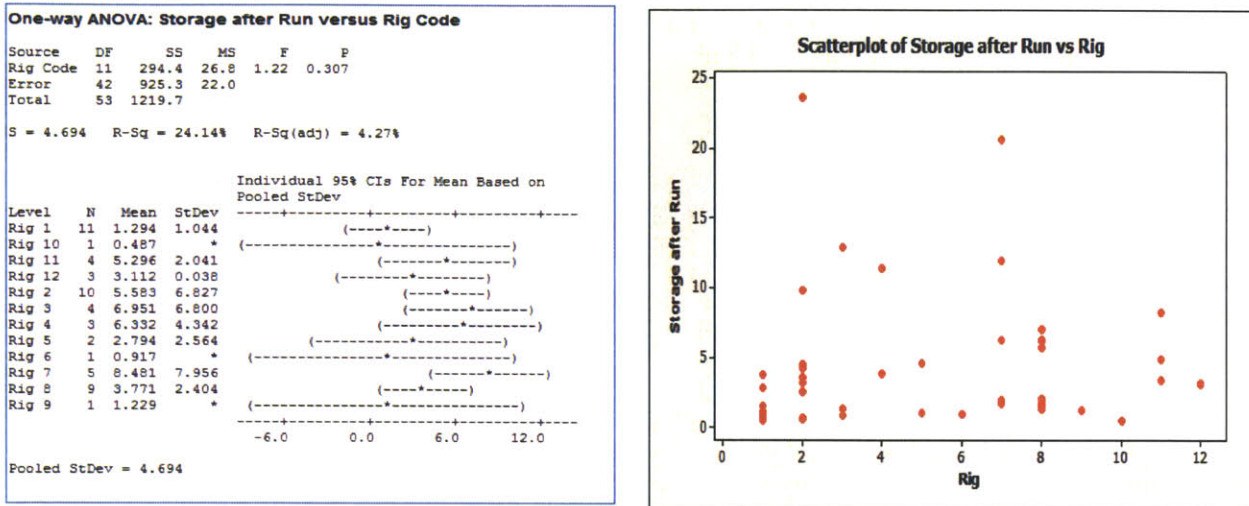#### 5.1.1.2.1.3.1 Relationship between Storage after Run time and Rig location

Figure 5-10 ANOVA analysis and scatterplot of Storage After Run vs. Rig Code

The P-Value in the Figure 5-10 indicates that there is no dependency of Storage after run time on the rig location.

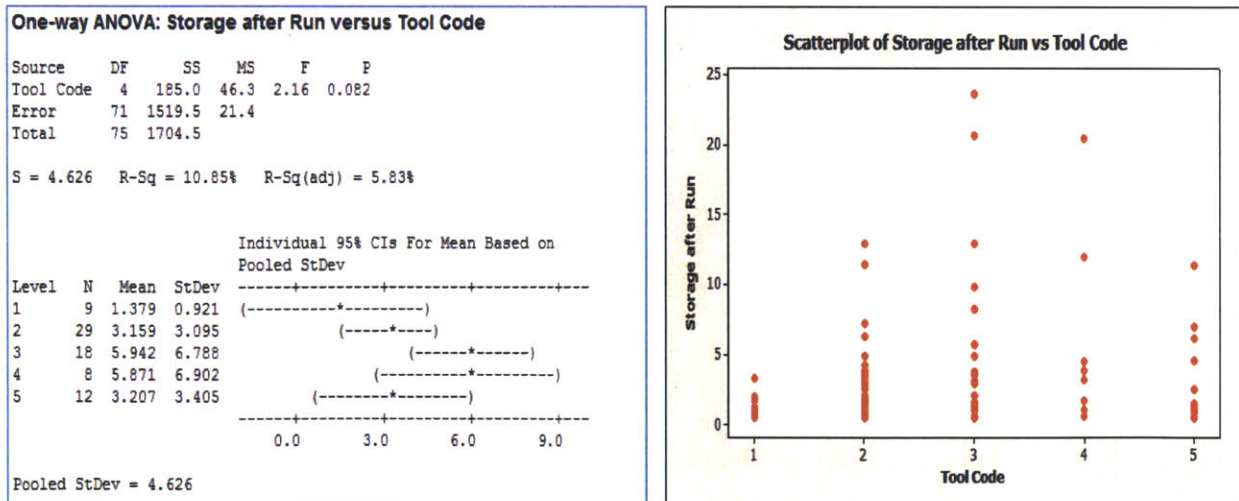#### 5.1.1.2.1.3.2 Relationship between Storage after Run time and Tool type

Figure 5-11 ANOVA analysis and scatterplot of Storage After Run vs. Tool Code

The P-Value in Figure 5-11 indicates that there is no dependency of Storage after run time on the type of tool.

5.1.1.2.2   Summary of the generalization of findings analysis

Table 5-8 Generalization of time analysis summary

Variable	Dependence on tool type	Dependence on Rig location	Remarks
Storage before Run	No	No	Overall average across tool type and rig location will be considered for further analysis
Storage after Run	No	No	
Transit time	No	Yes	The dependence on rig location will be ignored for further analysis. Overall average across rig locations will be considered for further analysis
BRT time	No	Yes	

5.1.1.3   *Maintenance Turn Around Times (TAT)*

The average turn-around times (TAT) for Red tools and Green tools were provided by the ABC Management based on maintenance time logs from the period

Table 5-9 Maintenance times for Red and Green tools (days)

Tool Family	Red Tool	Green Tool
Family 1	7.49	2.30
Family 2	10.75	1.10
Family 3	15.88	3.90
Family 4	26.38	2.40
Family 5	20.73	3.40

The tool specific TAT can be added to the general rental trip times to find tool specific end-to-end cycle times.

5.1.2   Estimating the magnitude of Time Savings

The magnitude of time savings is completely dependent on the return journey. It is believed that the magnitude of the time savings will be at the maximum equal to the storage after run time. Therefore, based on the analysis of storage after run times, time savings based on the sample will be probabilistically distributed with an expected value of 4.3 days. Based on the storage after run historic distribution, the savings will have a probabilistic distribution as follows -

Table 5-10 Probability distribution of Time Savings per trip assuming no storage after run

Time Savings (in days)	Probability Percentage
<0.5	7%
0.5-1.5	26%
1.5-2.5	13%
2.5-3.5	11%
3.5-4.5	13%
4.5-5.5	6%
5.5-6.5	7%
>6.5	17%
Total	100%

5.2   The Revenue Model

The purpose of the Revenue Model is to quantify the annual financial impact on revenue of the time savings of individual tool trips. The model takes as its input two trip profiles, a Status Quo profile and an Insourced profile, and compares the revenue generated by each.

5.2.1   Revenue Model assumptions

I.   Red and Green Tools

Typically, ABC sends a package of 3 identical tools to a rig, only 1 or 2 of which will ever 'Go Red" and actually be used BRT. As mentioned earlier, distinguishing between Red and Green tools is important for two reasons: first, because Green tools have different pricing structures than Red tools. In some situations, ABC does not get paid for Green tools; their role as a backup tool is included in the price of the primary Red tool, and ABC gets paid for it only if it is needed BRT. In other situations, ABC may get paid a Standby charge for some or all portions of a Green tool's trip. Second, as mentioned earlier, Green tools typically have a much shorter maintenance Turn Around Time (TAT) than Red tools; because they were never put into use, Green Tools return to base in a fresh state, and require significantly less maintenance time to re-customize and prepare for the next job. Because TAT plays such an important role in revenue dynamics, as we'll discuss later in the paper, accounting for Green tools separately from Red tools was a must.

II.   Insourced Trip Profiles

Beneath the Status Quo Trip Profiles are the estimated Insourced Trip Profiles – one Red and one Green. These profiles are identical to the Status Quo profiles except in one key respect: the Waiting Time. The difference between status quo and insourced Waiting times results in the *Time Savings Per Trip*, a single number that is the final output of the Time analysis. Note that the Time Savings Per Trip is the same for all tool families, since the benefits of an insourced logistics solution will likely be felt equally by all tools. In our model, a transportation asset reacts with the same performance regardless of tool

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type or tool quantity; for the sake of simplicity we did not prioritize boat pickup routines according to which tools have higher prices, for example, or which tools may be in shorter supply. In reality, ABC would almost certainly wish to do so – a topic that will be covered in Part5, Areas of Further Research.

III.   Tool Inventory

The model is based on a static tool inventory over a 12-month period; the inventory levels for each family are entered once, as is the estimated number of tools that go Red and stay Green. The model cannot account for dynamic inventory, nor can it account for variability in the fraction of Red vs Green tools within a given 12-month period. In reality, of course, ABC can never know with certainty ahead of time how many Green tools will be placed into action on a rig and go RED; but the model requires a consistent estimate of this figure nevertheless.

IV.   Pricing Structure

Pricing Structure varies significantly between geo-markets, and between individual jobs within the same geo-market. As stated in Part 2, the Operating Charge and Standby Charges determine how much ABC gets paid for BRT time, and all other cycle time. In reality, these tool charges vary from job to job; our model, however, computes revenue based on a single set of tool charges (a *pricing scheme*) over the course of the year. In order to gauge the sensitivity of revenue to different pricing schemes, we tested multiple schemes that varied not only in how much was charged for Operating and Standby times,

but importantly – varied in the *ratio of Operating charges to Standby charge*. In addition to specifying the quantity and mix of Red and Green tools, it is important to specify whether or not the current pricing scheme involves payment for GREEN tools; the Revenue model allows the user to specify if payment for GREEN tools is in effect, or not.

V.   Tool utilization levels

The tool utilization levels are assumed to be 100%. The present utilization levels are close to 100% for the top 3 tool families (ABC Management). These 3 tools form the major components of the entire model consisting of 5 tool families.

5.2.2   Effect of Insourcing on Revenue: A walk-through

Since the effect of insourcing (in Scenario#2 and #3) might be counterintuitive in nature, it is best to have a look at a representative example of revenue calculation and the critical factors which contribute to the revenue. Thereafter, we present the revenues calculated for the 3 scenarios.

In our hypothetical example that compares Scenario #1 and Scenario #2, 3 Family-1 tools are deployed from the ABC tool base to the XYZ offshore rig, which is located at sea, 152 miles from the dock used by ABC. 1 of the tools will eventually go Red – and 2 will remain Green. Upon completion of the mission, the tools are returned to the base and undergo maintenance and customization (as required) for the next job. For this example, we use the following price scheme:

Table 5-11 Daily tool charges for hypothetical example

Tool Family	Operating	Standby
Family 1	$ 4,145	$ 3,316
Family 2	$ 4,438	$ 3,550
Family 3	$ 30,000	$ 24,000
Family 4	$ 3,125	$ 2,500
Family 5	$ 4,438	$ 3,550

5.2.2.1 Status Quo Scenario

The Trip Profile described above (using Status Quo logistics support) is as follows:

Table 5-12 Status quo trip profiles for Red and Green tools

RED TOOLS	Status Quo Trip Profile (Historical Averages)					GREEN TOOLS	Status Quo Trip Profile (Historical Averages)				
	TAT (2011 Red Averages)	Transit	BRT	Waiting	End-to-End Cycle Time (days)		TAT (Green Averages)	Transit	BRT	Waiting	End-to-End Cycle Time (days)
Family 1	7.49	2.91	6.04	12.71	29.15	Family 1	2.30	2.91	6.04	12.71	23.96
Family 2	10.75	2.91	6.04	12.71	32.41	Family 2	1.10	2.91	6.04	12.71	22.76
Family 3	15.88	2.91	6.04	12.71	37.54	Family 3	3.90	2.91	6.04	12.71	25.56
Family 4	26.38	2.91	6.04	12.71	48.04	Family 4	2.40	2.91	6.04	12.71	24.06
Family 5	20.73	2.91	6.04	12.71	42.39	Family 5	3.40	2.91	6.04	12.71	25.06

To demonstrate the revenue dynamics, we will focus initially on the single Red Family-1 Tool, highlighted in yellow. The revenue streams for this tool are as follows:

Per Trip Operating Revenue (Revenue from Operating Charges for this tool) is given by:

(BRT Days * Operating Charge)   =

(6.04 * $4,145) = $25,035.80.   **Equation (5-1)**

Per Trip Standby Revenue (Revenue from StandBy Charges for this tool) is given by:

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$$((\text{Transit Days} + \text{Waiting Days}) * \text{StandBy Charge}) =$$

$$((2.91 + 12.71) * \$3,316) = \$51,795.92. \qquad \textbf{Equation (5-2)}$$

For a Per Trip Total Revenue of:

$$\text{Operating Revenue} + \text{StandBy Revenue} =$$

$$\$25,035.80 + \$51,795.92 = \$76,831.72. \qquad \textbf{Equation (5-3)}$$

In order to compute associated *Annual Revenue,* we broaden the focus to include not only the Green tools that accompanied the Red Tool in our hypothetical example, but also all of the Family-1 Tools in the regional inventory of ABC. From the Status Quo Trip Profiles in Table 2 (above), we can determine that our 3 Family-1 Tools collectively consume 76.3 Tool Days during the hypothetical trip:

$$\text{Tool Days Consumed Per trip} = (\text{\# of Red Tools} * \text{Red End-to-End Cycle Time}) +$$
$$(\text{\# of Green Tools} * \text{Green End-to-End Cycle Time}) =$$

$$(1 \text{ tool} * 29.15 \text{ days}) + (2 \text{ tools} * 23.96) = 77.1 \text{ Tool Days Consumed Per Trip}$$
$$\textbf{Equation (5-4)}$$

Note the difference between Green and Red cycle time results from the shortened TAT for Green tools; in every other respect, the cycle times are the same.

In the years 2010-2011, the inventory of Family-1 Tools was 45. Multiplying this quantity by the number of days in the year yields the Annual Tool Days Available for Family-1.

$$\text{Annual Tool Days Available} = \text{Tool Inventory} * \text{Days in Year}$$

$$= 45 \text{ tools} * 364.8 \text{ days} = 16{,}416 \text{ Annual Tool Days Available.} \quad \textbf{Equation (5-5)}$$

Given that the Tool Days consumed by a single trip of 3 Family-1 tools is 77.1, this means that the 45 Family-1 Tools can collectively make 213 trips in a year:

Trips Achievable = Annual Tool Days / Total Tool Days Consumed Per Trip

$$= 16{,}416 \;/\; 77.1 \text{ days} = 213 \text{ Trips Achievable} \quad \textbf{Equation (5-6)}$$

And Annual Revenue is given by:

Annual Revenue = Per Trip Total Revenue * Trips Achievable

$$= \$76{,}831.72 \;*\; 213 \;=\; \$16{,}365{,}688.47 \text{ Annual Revenue} \quad \textbf{Equation (5-7)}$$

Note that this is the Annual Revenue for an entire inventory of 45 Family-1 Tools, deployed in groups of 3 (1 Red, 2 Green) on jobs that fit the profile of Table 5-12. As mentioned earlier, this model assumes that demand is unlimited: as soon as a tool completes TAT, it is immediately sent out on another job.

5.2.2.2   Insourced Scenario

Now suppose the same trip was accomplished with an Insourced Logistics Solution that saved *4.3 days* of waiting time off of the original profile. The resulting Insourced Trip Profiles are as follows:

Table 5-13 Insourced trip profiles for Red and Green tools

		Insourced Trip Profile (Estimated)						Insourced Trip Profile (Estimated)			
RED TOOLS		TAT (2011 Averages)	Transit	BRT	Waiting	End-to-End Cycle Time (days)		TAT (Green Averages)	Transit	BRT	Waiting	End-to-End Cycle Time (days)
	Family 1	7.49	2.91	6.04	8.41	24.85	Family 1	2.30	2.91	6.04	8.41	19.66
	Family 2	10.75	2.91	6.04	8.41	28.11	Family 2	1.10	2.91	6.04	8.41	18.46
	Family 3	15.88	2.91	6.04	8.41	33.24	Family 3	3.90	2.91	6.04	8.41	21.26
	Family 4	26.38	2.91	6.04	8.41	43.74	Family 4	2.40	2.91	6.04	8.41	19.76
	Family 5	20.73	2.91	6.04	8.41	38.09	Family 5	3.40	2.91	6.04	8.41	20.76

The only difference between Table 5-12 and Table 5-13 is that the Waiting Times have been reduced by 4.3 days, from 12.71 to 8.41.

5.2.2.3   Comparison: Status Quo and Insource

Comparing the two scenarios, we identified two revenue dynamics at play: a *Revenue Loss* that results from the shortened cycle times, and a *Revenue Gain* resulting from the increased number of Trips Achievable. We will look at Revenue Loss first, again focusing on a single trip of 1 Red and 2 Green Family-1 Tools.

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5.2.2.3.1 Revenue Loss

Per Trip Operating Revenue is given by:

$$(\text{BRT Days} * \text{Operating Charge}) =$$

$$(6.04 * \$4,145) = \$25,035.80. \quad [\text{No change from Status Quo}] \quad \textbf{Equation (5-8)}$$

Per Trip Standby Revenue is given by:

$$((\text{Transit Days} + \text{Waiting Days}) * \text{StandBy Charge}) =$$

$$((2.91 + 8.41) * \$3,316) = \$37,537.12. \quad \textbf{Equation (5-9)}$$

For a Per Trip Total Revenue of:

$$\text{Operating Revenue} + \text{StandBy Revenue} =$$

$$\$25,035.80 + \$37,537.12 = \$62,572.92. \quad \textbf{Equation (5-10)}$$

Because the Insourced solution decreased Waiting Time from 12.71 days to 8.41, revenue changed as follows:

Standby Revenue: \$51,795.92 to \$37,537.12, a decrease of 28%; **Equation (5-11)**

Per Trip Total Revenue: \$76,831.72 to \$62,572.92, a decrease of 19%. **Equation (5-12)**

The takeaway here is that eliminating 4.3 days of Waiting Time has the undesirable effect of eliminating 4.3 days of Standby Revenue.

5.2.2.3.2 Revenue Gain

This negative dynamic in Per Trip Total Revenue, however, is countered by the increased number of Trips Achievable as a result of shorter cycle times. Returning to our example, the End-to-End Cycle Times for the Insourced Trip Profile **(Table 5-13)** are 24.85 days for Red Tools, and 19.6 days for Green Tools. Therefore, the Tool Days Consumed Per Trip are:

Tool Days Consumed Per Trip = (# of Red Tools * Red End-to-End Cycle Time) +

(# of Green Tools * Green End-to-End Cycle Time) =

$$(1 * 24.85) + (2 * 19.66) = 64.2 \text{ days}, \quad \quad \textbf{Equation (5-13)}$$

a 16% decrease compared to the Status Quo in **Equation (5-4)**. This 16% improvement in Tool Days Consumed Per Trip results in an increase in the Trips Achievable by the entire inventory of 45 Family-1 tools :

Trips Achievable = Annual Tool Days Available / Total Tool Days Consumer Per Trip

$$= 16{,}416 / 64.2 = 256 \text{ Trips Achievable} \quad \quad \textbf{Equation (5-14)}$$

an increase of 19% compared to the Status Quo in **Equation (5-6).**

Annual revenue is given by:

Annual Revenue = Per Trip Total Revenue * Trips Achievable

$$= \$62{,}572.92 * 256 = \$16{,}007{,}953.94, \text{ a decrease of 3\%.} \quad \quad \textbf{Equation (5-15)}$$

So, in our hypothetical example, the *Insourced Logistics solution makes slightly less revenue than the Status Quo*; the 19% more trips per year cannot overcome the 19% decrease in Per Trip Total Revenue.

5.2.2.3.3 Explanation of the lesser revenue generated by Insourcing

To see why lesser revenue is generated in insourcing scenario, we return to the Annual Tool Days Available, which in both scenarios has remained constant at 16,416 (see **Equation (5-5)**). Under the Status Quo scenario, revenue would have been earned in accordance with the breakdown of Annual Tool Days Available as shown in Table 5-14.

Table 5-14 Breakdown of annual revenue generating days

	Annual # of Days Where Charges Apply			
	Operating	StandBy	No Charges	Annual Tool Days Available
STATUS QUO	1287	3327	11802	16416
INSOURCE	1545	2896	11975	16416

Status Quo:

Operating Days = (# of Red Tools) * (BRT days * Trips Achievable) =

$\quad$ (1) * (6.04 * 213) = 1287 Operating Days $\qquad$ **Equation (5-16)**

StandBy Days[1] = (# of Red Tools) * ((Transit days + Waiting days)* Trips Achievable) =

$\quad$ (1) * ((2.91 + 12.71) * 213) = 3327 StandBy Days $\qquad$ **Equation (5-17)**

No Charges Days = (# of Red Tools * Red TAT days * Trips Achievable) +

---

[1] Note that in this example, both scenarios suppose that there is no payment for Green Tools; thus, this calculation for Standby Charges does not include Green Tools.

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(# of Green Tools * ((Green TAT + Transit days + BRT days + Waitng Days)* Trips

Achievable)) =

$$(1 * 7.49 \text{ days} * 213) + ((2 * (2.30 + 2.91 + 6.04 + 12.71)) * 213) = 11{,}802 \text{ No Charge}$$

Days. **Equation (5-18)**

The corresponding breakdown for the Insourced scenario is shown in Table 5-15.

Due to shorter cycle times, the Insourced scenario lost 431 StandBy days (3327-2896 days). Of

these, 258 were converted to additional Operating days, but 173 were converted into additional

No Charge days.

A closer look at the No Charge days reveals additional insights.

Table 5-15 Breakdown of No charge days for status quo and insourced scenarios

Status Quo					
No Charge Days					
No Charge: Red TAT	No Charge: Green TAT	No Charge: Green Transit	No Charge: Green BRT	No Charge: Green Waiting	No Charge: Total
1595	980	1240	2573	5415	11802
Insource					
No Charge Days					
Red TAT	Green TAT	Green Transit	Green BRT	Green Waiting	Total
1916	1177	1489	3090	4303	11975

By **Equation (5-18)**, the breakdown of No Charge Days for the inventory of 45 Family-1 tools is

shown above. As this Table shows, the benefit of 1,152 fewer Green Waiting Days (5415-4303)

is outweighed by an increase (declining revenue) in every other category; the aggregate outcome

is 173 additional days of No Charges when the Insourced solutions is used instead of the Status

Quo.

5.2.3 Summary Statistics for the Revenue Example walk-through

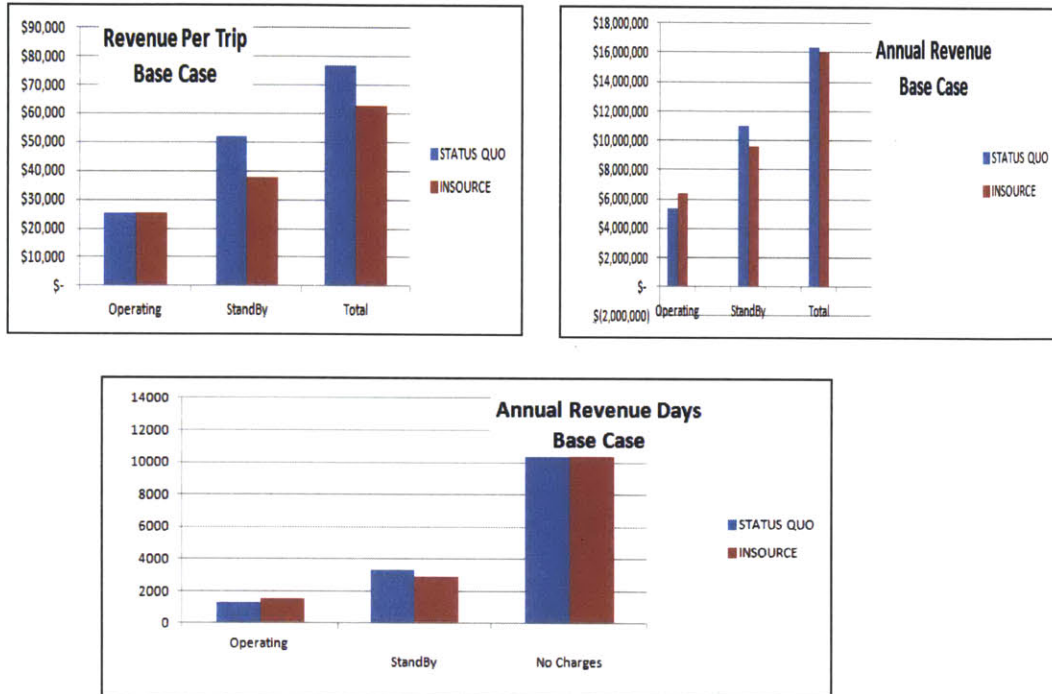*Summary Statistics* for the example described above are portrayed graphically in the following charts.

Figure 5-12 Summary Statistics for Base Case

5.2.4 Revenue Model Final Results

The final revenues obtained for each of the scenario are shown below:

Table 5-16 Revenue results

Scenario -->	Status Quo	Insource	Scenario # 3
Revenue	$ 142,886,771	$ 136,830,365	$ 168,010,348

5.3   Cost Model

The Cost Model is a straightforward representation of the anticipated costs of the Insource Scenario. Specifically, we included the following estimated costs in our Base Case:

5.3.1   Fixed Costs

Boat Rental:	$200,000 per month	[$2,400,000 pa]
Dock Space:	$18,000 per month	[$225,000 pa]
Licensing Fee	$50	[$50 pa]

5.3.2   Variable Costs: Per Trip and Mileage Costs

Truck haul:	$730.99 per trip (Maintenance Base to Dock)	[$172,492.80 pa]
Boat Fuel:	$949.05 per round trip	[$223,947.66 pa]
	1 mile per gallon @ $3.88 per gallon of diesel	
Boat Lubrication	$12.23 per trip	[$2,885.92 pa]
Dock Crane Fee:	$60.00 per trip	[$14,158.25 pa]

Note that the variable costs are per trip; the annual estimates at the right are based on 235 trips (boat is 2-way, truck is 1-way) per year, which is the number of trips we estimated using the Insource Base Case. We also found it unrealistic to expect that a single boat could operate for 365 days out of the year without regard for maintenance and upkeep. For this reason, we

estimated that an insourced boat could operate for 6 of every 7 calendar days – which limited the available boat days to 313 days out of the year. If, given the number of trips expected with an insourced scenario, the required boat days exceeded 313, we planned to lease 2 boats to handle the capacity, instead of 1.

5.3.3   Cost Model Final Results

The following table displays the total relevant costs:

Table 5-17 Cost results

Scenario -->	Status Quo	Insource	Scenario # 3
Transportation Cost	$ -	$ 5,698,331	$ -

As expected, only the insourcing scenario has a relevant cost associated with it.

5.4   Asset Estimation Model

As mentioned earlier, this step is only applicable for Scenario #3. The extra number of tools is required in Scenario #3 to cater to the extra demand applicable in the Insourcing scenario and Scenario #3.

The following table displays the increased number of tools required in Scenario #3:

Table 5-18 Increased number of tools required for Scenario #3

Tool Family	Tool Inventory
Tool Type 1	54
Tool Type 2	48
Tool Type 3	50
Tool Type 4	28
Tool Type 5	27

It should be noted that these are number of tools in the inventory which were used to calculate the revenue for Scenario#3 within the Revenue Model.

5.5 Net Income Calculation

As mentioned in the Methodology section, the Net Income estimate will receive the revenue from the Revenue Model and the relevant costs from the Cost Model. Along with these values historic averages are used for the ratio Total Revenue/ Service Revenue and the non-relevant costs as a percentage of the total revenue. The following table displays the final result for Net Income calculation.

Table 5-19 Net Income Results

	Status Quo	Insource	Scenario # 3	Computation Factor
Revenue	$ 142,886,771	$ 136,830,365	$ 168,010,348	
Total Revenue	$ 176,403,421	$ 168,926,376	$ 207,420,183	Service Revenue / .81
Direct Field Cost	$ 79,381,539	$ 76,016,869	$ 93,339,082	Total Revenue * .45
Transportation Cost	$ -	$ 5,698,331	$ -	
Other Field Cost	$ 1,764,034	$ 1,689,264	$ 2,074,202	Total Revenue * .01
Selling General & Administration (SG&A) also including R&E	$ 17,640,342	$ 16,892,638	$ 20,742,018	Total Revenue * .1
Operating Earnings (EBIDTA)	$ 77,617,505	$ 68,629,274	$ 91,264,880	Total Revenue - (Direct Field Cost + Transportation Cost + Other Field Cost + SG&A)
Depreciation	$ 26,460,513	$ 25,338,956	$ 31,113,027	Total Revenue * .15
EBIT	$ 51,156,992	$ 43,290,318	$ 60,151,853	EBIDTA - Depreciation
Tax	$ 18,416,517	$ 15,584,514	$ 21,654,667	EBIT * .36
Net Income	$ 32,740,475	$ 27,705,803	$ 38,497,186	

5.6   Return on Asset (ROA) Model

Having looked in detail at revenue, we now turn to the final calculations: the effect of insourcing on ROA.

The ROA Model takes as input the revenue and costs (the income) of the previous models, and divides it by the Net Book Value (NBV) of the assets involved in the particular scenario. It uses actual asset costs as provided by ABC, and computes a straight-line depreciation of these assets based on an average tool life of 48 months. The model assumes that the average tool life of 2

years. The output of the model is a single ROA percentage for each scenario that can be used to evaluate the efficacy of one scenario versus other scenarios.

Table 5-20 ROA results

Scenario -->	Status Quo	Insource	Scenario # 3
ROA	102%	86%	101%

The Status Quo scenarios have higher ROA, mainly due to the direct costs of not managing one's own logistics; ROA from insourcing yields lower ROA compared to the Status Quo.

5.7   Model Limitations

The increased level of output provided in insourcing scenario and scenario #3 may not accurately reflect actual future demand projections. We arrived at this level of output when we optimized current inventory using the insource scenario; the result, in one hypothetical example, is the ability to service approximately 27% more jobs. If, in reality, the desired level of output does not equal 188 jobs, the actual ROA levels move away from the results we obtained.

Moreover, our scenarios depict three situations that can be thought of as representing extreme points on a continuum of holding inventory constant on the one hand, and holding demand constant on the other. Assuming for a moment that future demand will not require an output equivalent to scenarios #2 and 3 exactly, ABC may (and probably will) elect to implement a *combination* of *some* increased inventory and *some* insourced logistics to meet future actual demand. Our model, while very helpful in illuminating the general financial contours of process

and asset interaction, does not pinpoint the optimal combination of asset and process mix that ABC may in fact implement.

5.8   Summary of Results

Collectively, our models point to two important conclusions. First, for a given future level of output that exceeds the current level of output, the *Status Quo Logistics solution will result in a better ROA than the Insourced Logistics solution*. All other things being equal, it is better to meet increased demand by purchasing more tools than by insourcing logistics (and keeping tool inventory constant). However, as we will show, the competing scenarios produced ROA outcomes that were very close, with the results being very sensitive across the range of reasonable inputs.

The second important conclusion is that, in most cases, a higher level of output -- servicing more jobs (meeting a higher level of demand) actually results in *less revenue* (and *lower ROA*) than by keeping output constant. While this conclusion in itself may not matter (keeping output constant is probably not an option: demand *is* growing and ABC *will* increase output in the future), the implications are vital to understanding the revenue dynamics of the two-part price structure (standby and operating charges). As our analysis shows, the benefits of increased asset velocity (more days when ABC can charge for operating charges instead of standby charges) are often outweighed by the loss of standby charges resulting from less tool waiting, and the increase in non-revenue-generating maintenance days resulting from more turns. This counterintuitive

conclusion may be important in shaping future pricing and logistics decisions, as we will see

below.

6 Sensitivity Analysis

6.1.1 Payment for Green Tools

The Base Case does not include payment for Green tools; if it did, the revenue gap between Status Quo and Insource would grow from 2.2% to 10.3%. The following tables show the 3 key metrics for the Base Case side-by-side with the corresponding metric for the 'Payment for Green Tools' scenario.
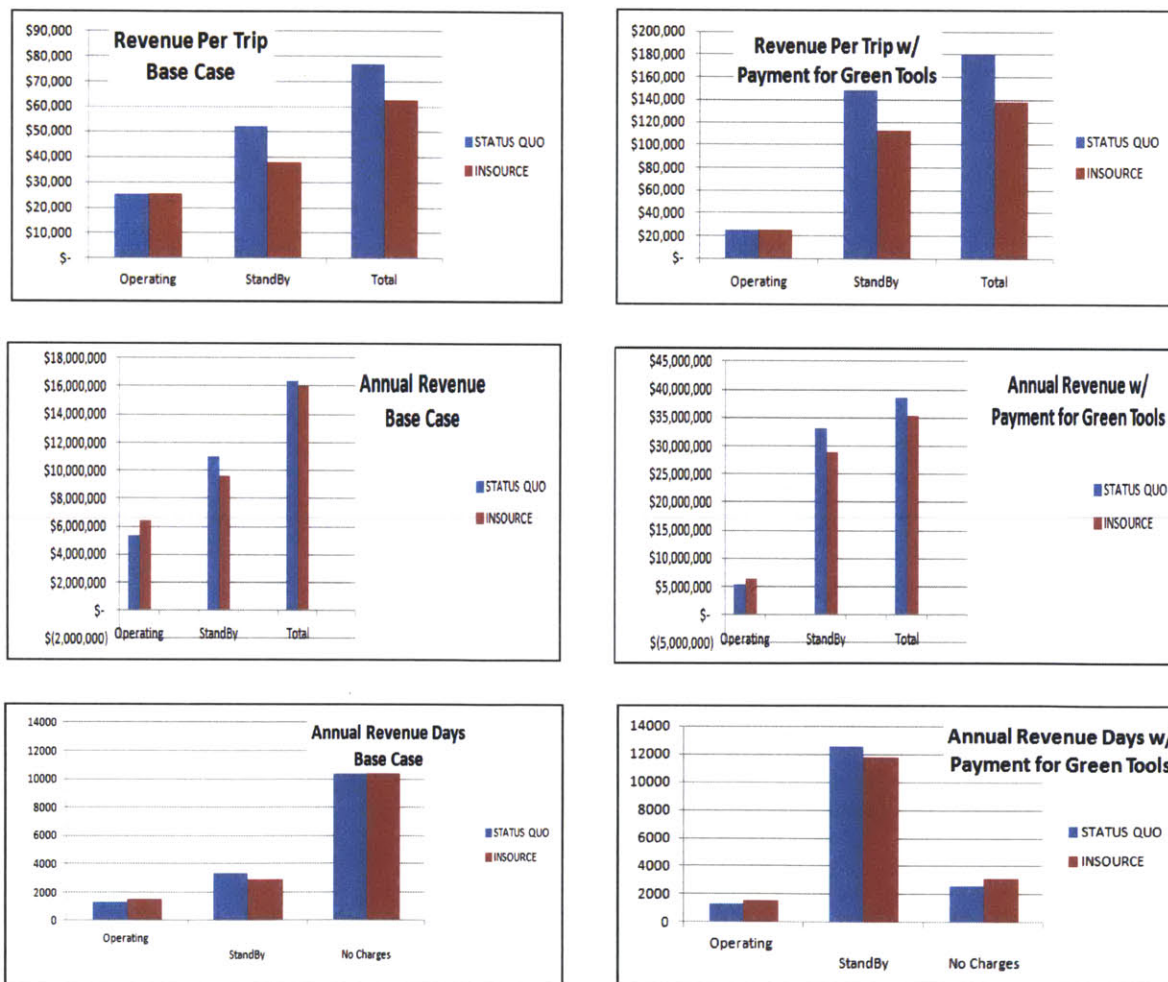

Figure 6-1 Summary Statistics for Payment for Green Tools vs. Base Case

This further gap in revenue is due mainly to a net increase in StandBy charges for both Status Quo and Insourced scenarios; because gained StandBy charges increase in both scenarios at the same *rate*, the revenue difference between the two scenarios grows proportionally wider. Note that Operating Charges stay constant regardless if Green tools are paid or not. Overall, getting paid for Green tools increases revenue – but it also increases the gap between Status Quo and Insourced scenarios.

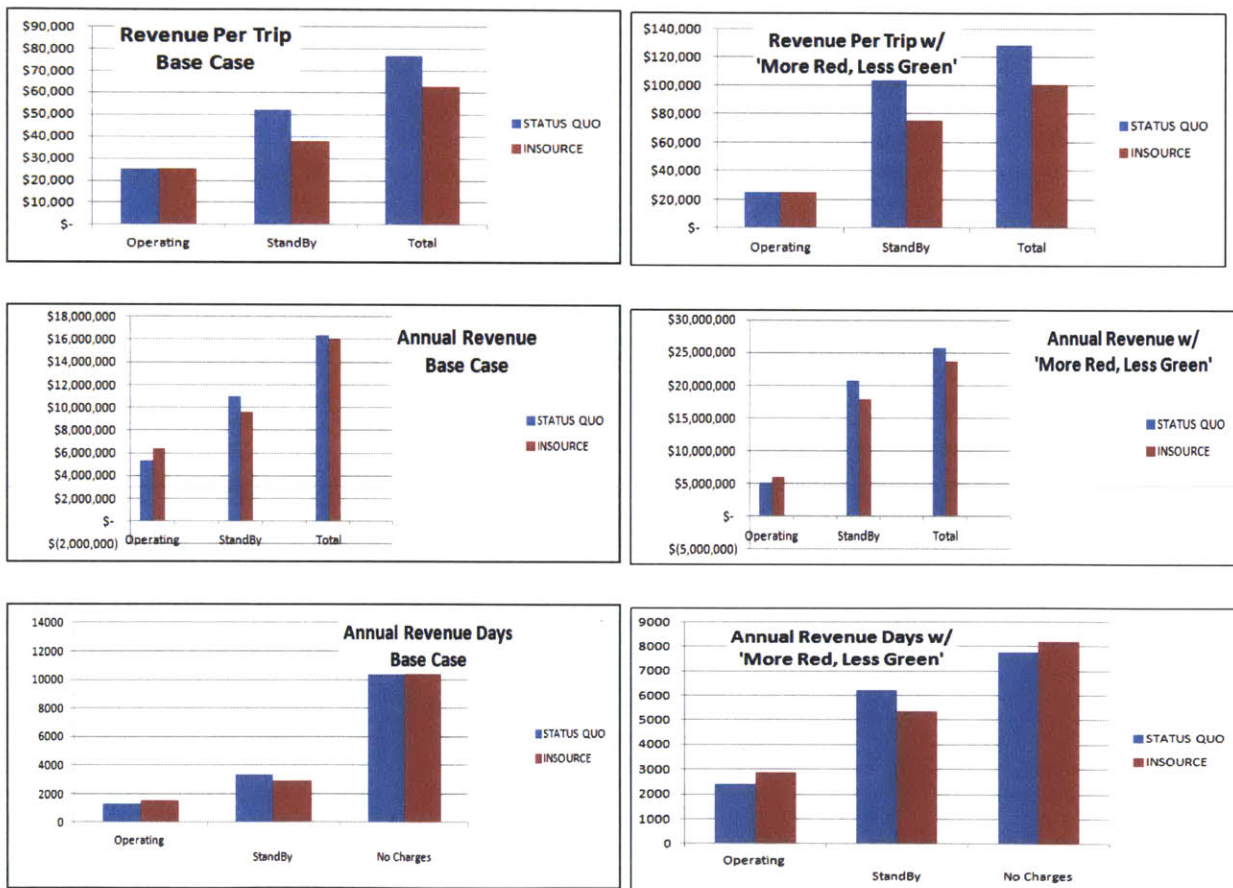### 6.1.2   More Red – Less Green

Figure 6-2 Summary Statistics for More Red Less Green vs. Base Case

The Base case was run with a mix of 1 Red and 2 Green tools per trip. If the mix was reversed, with 2 Red tools for every 1 Green, the Insourced scenario would generate 12% less revenue than the Status Quo.

It should be noted that – in reality – ABC will never be able to predict with certainty exactly when during a trip a tool will go from Green to Red; such timing depends on the unique situation on that rig. A change in drilling procedures, a lost-in-hole event, or simply the gut feel of the Rig Operator can all result in a Green tool being called forward into Red status. Our model, however, assumes that a tool is either Red or Green for the duration of the trip, and computes revenue accordingly.

6.1.3   Price Sensitivity

The previous cases were all run with Daily Tool charges that correspond to Rig #1; in order to see the effect of different prices, we used two alternative price structures that correspond historically to different customers ("Rig #2" and "Rig #3"). Without examining the rationale behind the different pricing schemes, we can draw inferences from the model's results.

Table 6-1 Price sensitivity due to Standby-Operating Ratio across multiple scenarios

	Rig #1		Rig #2		Rig #3	
PRICE SENSITIVITY AND DAILY TOOL CHARGES						
Tool Family	Operating	Standby	Operating	Standby	Operating	Standby
S-O Ratio	0.80		0.50		0.40	
Family 1	$4,145.00	$3,316.00	$4,145.00	$2,072.50	$3,000.00	$1,200.00
Family 2	$4,438.00	$3,550.00	$4,438.00	$2,219.00	$3,000.00	$1,200.00
Family 3	$30,000.00	$24,000.00	$30,000.00	$15,000.00	$16,000.00	$6,400.00
Family 4	$3,125.00	$2,500.00	$3,125.00	$1,562.50	$7,800.00	$3,120.00
Family 5	$4,438.00	$3,550.00	$4,438.00	$2,219.00	$2,800.00	$1,120.00
	Total Annual	% Change	Total Annual Revenue	% Change	Total Annual Revenue	% Change
Status Quo: Base Case	$142,886,770.80		$69,190,306.68		$61,387,038.88	
Insource: Base Case	$136,830,364.55	-1.79%	$68,664,704.73	-1.32%	$62,021,247.83	1.03%
Status Quo: "Base" Case + Paid for Green Tools	$335,539,187.57		$147,222,984.68		$123,813,181.28	
Insource: "Base" Case + Paid for Green Tools	$300,996,602.20	-10.29%	$135,099,273.76	-8.60%	$115,168,903.05	-6.98%
Status Quo: "More Red -- Less Green"	$211,302,651.47		$94,755,502.00		$81,089,011.32	
Insource: "More Red -- Less Green"	$189,610,877.49	-10.27%	$87,422,574.97	-8.18%	$76,021,382.01	-6.25%

Table 6-1 shows that the only scenario that produced positive revenue as a result of an Insource solution was the Base Case, with Rig #3 prices. The reason for this result is the ratio between Standby charges and Operating charges, which we call the "S-O Ratio." Only when the S-O Ratio is small enough – in this case, 0.4, does the increase in revenue due to Operating charges outweigh the loss in revenue from Standby charges. Furthermore, the Breakeven So-Ratio, the point at which the ratio starts to produces a net revenue gain, is dependent on the exact makeup of the trip profiles in the model. The mix of operating days to standby days in a trip profile will determine the S-O ratio that is necessary to produce positive revenue. Because in reality the Trip Profiles will vary from job to job, it is not relevant for us to compute the breakeven point in our hypothetical example. It is relevant, however to conclude that the proportion of Operating Charges to Standby Charges has a direct correlation to the revenue gain observed with an Insourced logistics solution. Furthermore, it is beneficial for ABC to be cognizant of this ratio and its effect on revenue resulting from all two-part pricing schemes.

As expected, the overall ROA result is also sensitive to the tool rental pricing schemes, and the cost of renting boat(s). Since the rental boats make up the single biggest direct cost of Insourcing, their price has a big impact on the ROA. In the examples above, our rental price was $200,000 per boat per month; if that price increased to $300,000 per month, the ROA gao between Status Quo (Scenario #3) and Insourced Logistics (Scenario #2) would widen to 20%:
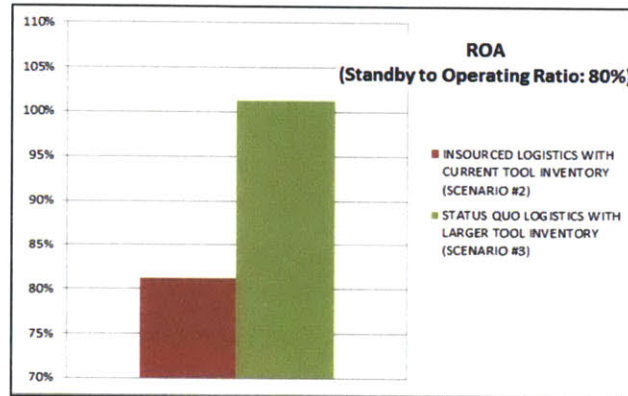

Figure 6-3 ROA with 2 boats, each at cost of $300,000 per month(101% to 81%)

The ROA result is also sensitive to the tool rental pricing scheme. For example, if we change the pricing scheme from an 80% S-O Ratio (which is what was used in the graphs above) to a 40% S-O Ratio, the gap between Status Quo and Insourcing narrows to 3%:
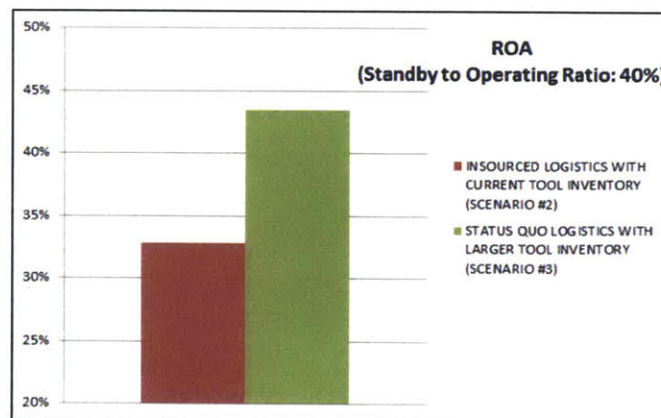

Figure 6-4 ROA with 2 boats, each at cost of $200,000 per month (43% to 33%)

These results suggest a few points. First, the insourcing initiative is sensitive to reasonable fluctuations in the cost of a boat rental. While a 50% swing (from $200,000 to $300,000) in monthly rental cost may sound extreme, it is probably not outside of the global range of possibilities across geo-markets. Second, the important role that the Standby-Operating Ratio plays in revenue generation is clearly echoed in ROA.

Interestingly, conversations with ABC executives indicate that there are situations when ABC receives no Standby Charges at all, in exchange for a higher Operating Charge. The hypothetical pricing scheme below depicts such a situation, with Operating Charges double what they are in every other scenario we used.

Table 6-2 Pricing scheme with operating charges doubled and no standby charges

Daily Tool Charges		
Tool	Operating Charge	Standby Charge
Family 1	$6,000	$0
Family 2	$6,000	$0
Family 3	$32,000	$0
Family 4	$15,600	$0
Family 5	$5,600	$0

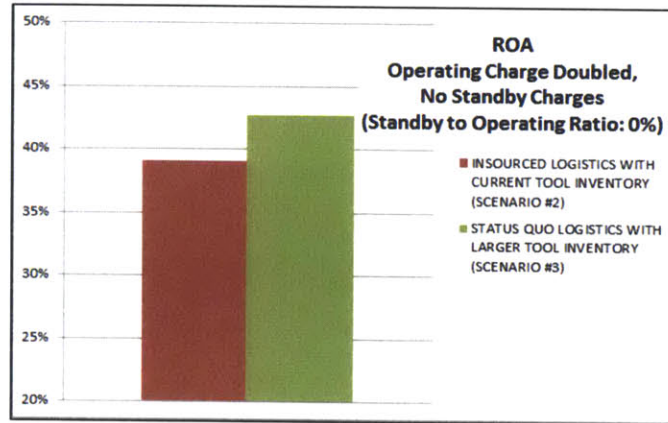As the graph below shows, this pricing scheme still favors the Status Quo, but by a small margin.

Figure 6-5 ROA with 2 boats, each at cost of $200,000 per month (43% to 39%)

Together, sensitivity to boat rental prices and the S-O Ratio reinforce the fact that Insourcing is certainly *not* a 'no-brainer'. Given that the two options – insourcing transportation or buying more tools – can yield results that are so close in terms of ROA, it magnifies the importance of the costs that we have not endeavored to quantify here. For example, if the ROA outcome is something close to a toss-up, a decision in favor of status quo logistics may very well be driven by the uncertainty of the effect of insourcing on ABC's relationship with its clients. Conversely, a decision to insource inbound tool logistics may be based on the potential of eventually insourcing the inbound *and* the outbound portions. These are issues that we have dealt with here only peripherally.

7   Areas of Further Research

In the course of this research, we have been exposed to a number of ideas that may inform ABC's efforts to increase ROA in a highly competitive and rapidly growing global market. Although our Research Question was tightly focused, we thought it might be valuable to offer our thoughts on several of them.

First, the idea of floating tool maintenance facilities would greatly increase the attractiveness of logistics insourcing by dramatically increasing asset velocity. Second, the ABC shipping data on which we based our research was highly affected by statistical outliers; there were a few rare occasions when tools stayed on a rig for weeks after casing had been completed. In most cases, we stripped out those outliers to provide a more accurate picture of the typical tool trip. This decision was reinforced by ABC managers who identified the unique circumstances of these outliers and told us that they were the result of specific 'one-time' conditions (such as the 2010 Gulf moratorium). However, there is still a case for "cherry-picking" existing outliers and managing their transportation on a case-by-case basis, leaving the majority of tool logistics to the client. With more robust analysis of the customers and their rigs, it might be possible to build a predictive model to identify likely outliers ahead of time, and plan to handle outlier logistics only. It is also worth exploring an alternative plan that maintains a rental boat on a monthly retainer fee with an additional per-trip cost. This would save the cost of full-time insourcing, while reaping the benefits of expediting those tools most likely to experience long waiting times.

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