Business Value of Information Technology
A Data Analytics Approach

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April 21, 2018

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Part I

Business and IT Strategy

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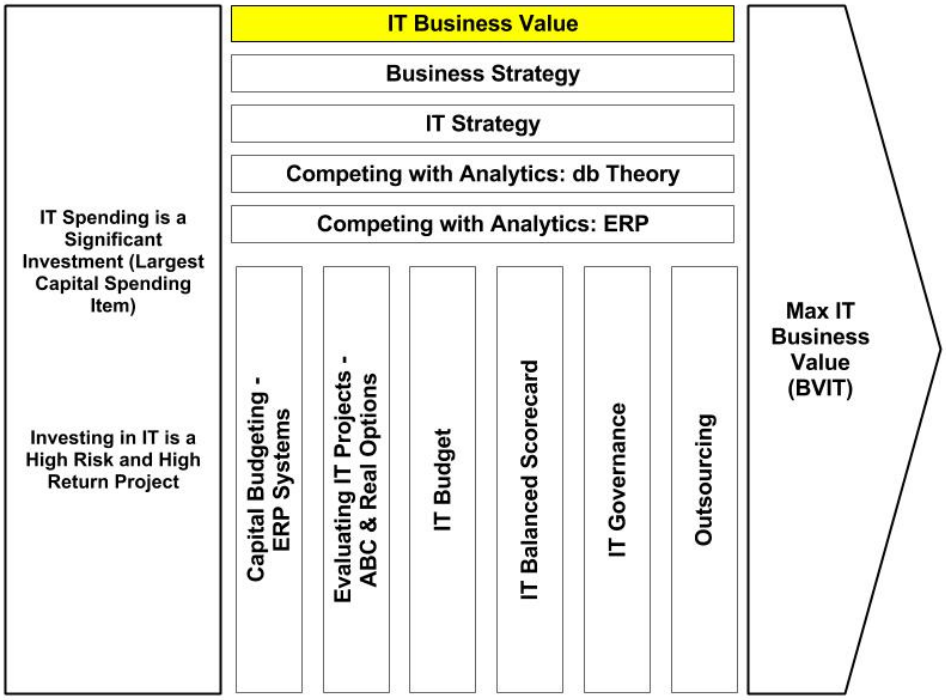
Chapter 1

IT Business Value (ITBV) Proposition



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Learning Objectives

By the end of this chapter, students should be able to describe, interpret, and apply the following concepts:

- Information Technology (IT) and Information Systems (IS)
- Patterns in IT spending over time and across industries
- New technologies and implications for business
- Technology adoption theories
- The IT business value proposition
- Methods for measuring IT business value
- IT productivity paradox

1.1 Introduction

Information technology is ubiquitous! Take a moment to think of how many times and how many different forms of information technology you encounter on a daily basis as a university student. Your first encounter with your school's information systems started when you submitted your on line application. When you were admitted to your university, an account was created that gave you access to your school's email (student@university.edu or student@university.ca).

As a student, you have access to a wireless network that covers all buildings on campus, you use a learning management system such as Blackboard or Desire2Learn to keep up with your class related material (see Figure 1.1), you use a database like QUEST to look at your grades and the balance of your account, and you use the library's web site to search for books and articles and access various databases.

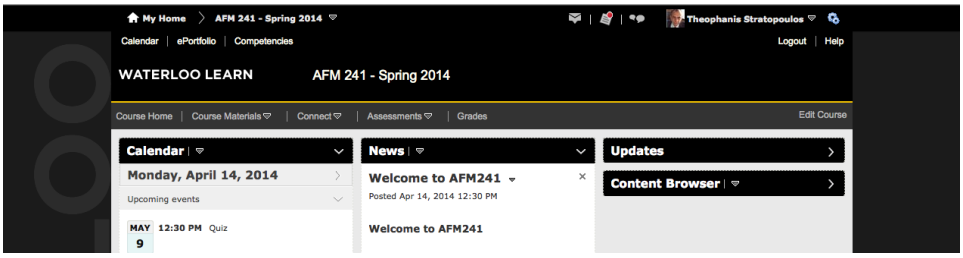

Figure 1.1: D2L - Learning Management System at the University of Waterloo

The term information technology refers to development, maintenance,

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and use of computer systems, software, and networks for the processing and distribution of data (Merriam-Webster dictionary). On the other hand, the term information systems combines both the technical components and human activities within the organization. It describes the process of managing the life cycle of organizational practices related to information technology.

When we talk about a firm's information systems, we refer to its information technology infrastructure, data, application systems, and personnel that employ information technology to deliver information and communications services in an organization. In addition to this, the term information systems refers to the management of the organizational function in charge of planning, designing, developing, implementing, and operating the systems and providing services. Professionals and academics refer to information technology simply as **IT**, they refer to information systems as **IS**.

Organizations use IT to capture, store, manipulate, and present data in order to support the firm's business processes and value adding activities.[1] As an example, let's look at how a firm uses IT when a sale is made. The firm will use their cash register, which is just a component of a company's point of sales (POS) system, to capture sales transactions (Figure 1.2)[2]. These transactions will be aggregated by product and used to automatically update the firm's inventory through its inventory management system. The inventory management system will keep track of inventory levels, and when inventory levels fall below a required threshold, a purchase order will be issued to the appropriate vendor. In many firms, the vendor's IS may be linked directly to the customer's inventory management system allowing closer collaboration.

Inventory management is just one of the firm's activities that uses these sales transactions. The firm's marketing department will organize and analyze these sales in order to see whether its marketing campaign increased sales, or analyze sales data for patterns (data mining) that can be used to explore different pricing models, or print out coupons at the cash register customized to their customers' shopping habits. The accounting department will combine sales figures with expenses (payments to vendors, commissions to salespeople, etc) in order to establish the firm's financial position.

A sign of a well-functioning IS is that users take it for granted. It is there

[1] For example, in retail, taking an order and providing the customer with a product or service as well as collecting the payment is an example of the typical order-to-cash process. Inbound logistics, production, sales, and R&D are some examples of typical value adding activities. In Chapter 2 (p. 50) we will talk about business processes and value adding activities in more detail.

[2] This POS picture is from http://pos-systems-review.toptenreviews.com/

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Figure 1.2: A Point of Sales System

when we need it, and of course - at least some of us - enjoy having access to the latest gadgets and tools. However, for your university and for any organization (profit or non-profit) IT is also a huge cost. IT constitutes an investment that the organization makes, and like all investments, the hope is that the present value of future benefits will be more than the cost.[3]

Seeing IT as an investment is our main focus in this course and book. Anecdotal evidence and academic research has shown that not all firms are successful in extracting value from their IT investments. Our focus is on management-related factors that contribute to a firm's ability to maximize its pay-offs from IT investments (i.e., maximize its IT business value). As we will see, this requires development of an IT strategy and planning on how to deal with risk in order to achieve desired performance outcomes, compliance, and accountable delivery of value. Given that most of the times business decisions have to be made under conditions of uncertainty; whenever this is possible, we will be using business analytics to support decision making. This means that we will try to transform and leverage quantitative and qualitative data into useful information that can be used to support decision making.

In this first chapter, we are going to look at patterns in IT spending (how much firms spend on IT?), some of the recent technological innovations (what kind of IT investment firms make?), patterns in the adoption of technological innovation (how is the timing of IT investments related to expected risks and rewards?), and some of the most common arguments

[3]Universities allocate, on average, 5.6% of their estimated revenues on IT.

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used to justify IT investments (what are the expected payoffs from IT investments?). This is also known as the ***business value of information technology***. We will close this chapter by reviewing the three most commonly used methods to assess the value of IT investments, and some early evidence on actual payoffs from IT spending.

1.2 IT Spending - Trends and Patterns

Firms plan for their IT spending in their IT budget and IT budgeting process. The typical IT budget includes such expenditures as IT staff salaries, training of IT staff and system users; upgrades and replacements of telecommunications, networking, and hardware; maintenance and development or purchase of software applications; payments to vendors and services firms, and Internet based costs. Thus, IT budgets support many, if not most, of a firm's requests for IT services.

An alternative approach is to make the distinction between operational IT spending versus capital expenditures (investments in new technology). This distinction is very important because operational IT spending is about supporting the status quo, while new investments are about exploring new opportunities. Operational spending implies maintaining current IT infrastructure and ensuring that it is running efficiently. Capital expenditures are related to new IT projects that have the potential to transform the way a business functions and competes.[4]

Over the years the amount that firms have been spending on IT has been rising. According to a study by the Bureau of Economic Analysis of the U.S. Department of Commerce, the percentage of capital expenditures that American companies allocated to information technology has increased from around 5% in 1965, to 15% in the eighties, and almost 50% in the late nineties. While the dollar amounts vary over time and across industries, the fact is that for most firms, IT spending constitute one of their largest capital spending items, and their IT budget represents a sizable component of the overall firm budget.

In spite of the sheer volume of IT spending,[5] regulatory agencies do not require firms to report IT spending data. International Financial Reporting Standards (IFRS) and U.S. Generally Accepted Accounting Principles (US

[4]In accounting terms, a capital expense is one that a company incurs when it upgrades an asset, representing an improvement to the business. In contrast, operating expenses are recurring costs required for a company's day-to-day operations, such as administrative or maintenance expenses.

[5]worldwide IT spending has been estimated at $3.8 trillion

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GAAP) do not require firms to disclose IT spending in financial statements. As a result, IT spending data is not readily available. However, several consulting firms and magazines - e.g., Harte Hanks, Gartner, Computer Economics, InformationWeek - survey a large number of firms and provide IT spending benchmarking information.

InformationWeek (IW) was producing an annual list of the largest IT users (from 1989 to 1996) and most innovative IT users (from 1997 to 2013). The list was known as the IW500. Table 1.1 is a compilation of data from several issues of Information Week 500 annual reports. It summarizes IT spending expressed as a percentage of revenues for the last seven years and across a wide spectrum of industries. Observing the figures on IT spending presents some interesting patterns.

1. Average IT spending across industries and over the years has been around 3%.
2. The highest IT spending industries include: Banking and Financial Services, Media and Entertainment, Consulting and Business Services. In general, spending in service related industries (Banking and Financial Services, Media and Entertainment, Consulting and Business Services, Healthcare and Medical, Hospitality and Travel, Insurance) is higher compared to the average across all industries. These are the relatively more *IT intensive industries*.
3. Lowest IT spending industries: Metals and Natural Resources, Construction and Engineering, and Automotive.
4. IT spending in the IT industry (this includes firms producing hardware and software) is relatively high. However, this is lower than the annual spending in the Banking and Financial Services industry.
5. In certain years and due to industry specific events, the IT spending is unusually high.
6. As you look at this table, you may want to consider the following question: What happens to IT spending during the business cycle. Does the IT spending increase during the periods of economic expansion and does it decrease during recessions?[6] Is this pattern reflected in table 1.1? The Side Note: IT Spending During the Recession provides some more material on this matter.

[6] According to the *National Bureau of Economic Research*, the US economy was in a recession from December 2007 to June 2009. This is known as the global financial crisis.

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Industry	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Automotive	0.012	0.010	0.010	0.016	0.010	0.010	0.010
Banking & Financial Services	0.063	0.080	0.076	0.082	0.087	0.090	0.084
Biotech & Pharmaceuticals	0.043	0.040	0.034	0.037	0.031	0.031	0.034
Chemicals	0.020	0.020	0.016	0.018	0.018	0.014	0.018
Construction & Engineering	0.007	0.015	0.011	0.012	0.012	0.010	0.011
Consulting & Business Services	0.040	0.043	0.043	0.037	0.040	0.030	0.042
Consumer Goods	0.021	0.020	0.015	0.022	0.023	0.022	0.020
Distribution	0.010	0.010	0.010	0.010	0.012	0.012	0.010
Electronics	0.030	0.030	0.030	0.021	0.020	0.018	0.020
Energy & Utilities	0.020	0.020	0.016	0.018	0.020	0.015	0.015
Healthcare & Medical	0.040	0.040	0.029	0.035	0.040	0.041	0.040
Hospitality & Travel	0.029	0.020	0.029	0.030	0.030	0.031	0.030
Information Technology	0.040	0.040	0.031	0.039	0.050	0.050	0.033
Insurance	0.030	0.030	0.034	0.033	0.040	0.040	0.039
Logistics & Transportation	0.020	0.020	0.017	0.018	0.020	0.022	0.020
Manufacturing	0.020	0.020	0.018	0.019	0.020	0.023	0.021
Media & Entertainment	0.050	0.050	0.050	0.135	0.040	0.050	0.048
Metals & Natural Resources	0.008	0.010	0.008	0.010	0.010	0.009	0.011
Retail: All	0.020	0.020	0.022	0.017	0.015	0.020	0.020
Retail: General Merchandising	0.020	0.020	0.017	0.017	0.013	0.012	0.024
Retail: Special Merchandising	0.020	0.020	0.031	0.018	0.015	0.020	0.019
Telecommunications	0.052	0.050	0.033	0.032	0.028	0.032	0.040
Higher Education							0.056
Descriptive Statistics	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Average	0.028	0.029	0.026	0.031	0.027	0.027	0.029
St.Deviation	0.015	0.017	0.016	0.028	0.018	0.019	0.018
Minimum	0.007	0.010	0.008	0.010	0.010	0.009	0.010
First Quartile	0.020	0.020	0.016	0.017	0.015	0.014	0.019
Median	0.021	0.020	0.026	0.020	0.020	0.022	0.021
Third Quartile	0.040	0.040	0.033	0.035	0.038	0.032	0.040
Maximum	0.063	0.080	0.076	0.135	0.087	0.090	0.084

Table 1.1: IT Spending as a Percentage of Projected Revenue

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Side Note: IT Spending During the Recession

McKinsey Quarterly In a report written in 2009, Spang [145] says: "... When downturns hit, there is a certain inevitability to their impact on IT. Declining profits will place tremendous pressure on IT budgets in most sectors and regions. CIOs will be called on to rationalize projects, downsize organizations, renegotiate contracts, and seek out other cost-reduction opportunities. Much has changed, however, since the last big downturn, in 2001: technology budgets are larger, businesses have automated more processes, employees make greater use of technology-based productivity tools, and e-commerce has moved to the core of day-to-day operations. At the same time, IT organizations have established better mechanisms to govern IT decision making and have consolidated local IT operations to cut costs."

1.3 Emerging Technologies

On average large North American firms spend $50 to $90 million per year in new IT products and services [152]. The type of IT initiatives that firms invest on vary over time. In the last few years, business analytics, big data, the Internet of Things (IoT), cloud computing, machine learning, autonomous vehicles, augmented reality and virtual reality have attracted the attention and financial resources of firms vying to leverage IT in order to improve their competitive position. In the financial services sector and for accounting firms, the FinTech revolution and possibilities offered by the blockchain promise to alter the competitive landscape.

Business/Data Analytics refers to the use of large data sets and advanced statistical analysis to identify the most profitable customers, select the best price, design the best supply chain routing, or identify the best person to hire [28]. In order to implement business analytics companies need data. Typically, data is generated either internally or externally. Firms generate information internally, by leveraging traditional sources such as the POS. By monitoring sales through POS, firms can learn what products they sell, at what price, when they sell, whether sales respond to promotions, and who are their customers. Similarly, management can get a accurate representation of the firm's financial health by analyzing data collected by the firm's accounting department. Notwithstanding the importance of these data, technological changes have introduced new sources of user generated

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data, such as posts on Facebook or tweets, and machine generated data, such as those produced by Radio-Frequency Identification (RFID) chips.

Social networking applications, such Facebook and Twitter, and tools enable companies to integrate various aspects of their business as well as stay on top of current trends emerging amongst consumers and society. The Side Note: Investing in Sentiment Analytics (p. 11) shows how Best Buy implemented a business analytics (sentiment analytics) by leveraging data generated from Facebook. **GPS-enabled, location-aware Web applications** leverage GPS technology to locate users and suggest discounts or special offers based on a user's location. Furthermore, they can be used to recommend social events and find other people that the user might be interested in.

SideNote: Investing in Sentiment Analytics

According to Murphy [108] " ... For several years now, Best Buy's customer insight group has been using software to monitor the mood on blogs and social networks. This is called 'sentiment analytics.' Leveraging the feedback from such sentiment analytics helped Best Buy realize how unpopular its 'restocking fees' were. More research revealed that these fees were unpopular among the group of most profitable and influential customers. Best Buy decided to drop almost all restocking fees."

Transponders like the one in Figure 1.3 allow you to cross a toll both on a highway without having to stop. This is just one of the benefits of **Radio-Frequency Identification** (RFID). The RFID chips, when triggered by sensors, emit short bursts of identifying data streamed via radio waves.

Walmart was one of the first firms to experiment with the new technology. They embedded RFID chips in products (or their packaging) to assist with automatic identification and data capture. Walmart uses RFID chips to track individual pieces of merchandise. For example, rather than simply identifying an item as a box of cookies (as bar codes do), an RFID chip can uniquely identify a particular box of cookies and enable it to be tracked all the way through the order to payment chain, from the warehouse to a consumer's shopping cart. This level of uniqueness in tracking can, for example, aid in the removal of expired merchandise from store shelves or assist in locating items designated as part of a product recall.

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It is simply a matter of time before Amazon's experiment with cashierless grocery store will become the norm. This means that we will be able to simply walk in front of cash register with an entire shopping card and have everything scanned and the appropriate amount charged on your credit card.[7]

Embedding such smart objects, as the RFID chips, on all imaginable physical things (heart pacers, pallets, cars, refrigerators, locomotives, jet engines, bridges, etc.) makes it possible to connect them to the Internet. This means that we can access them and even control them from a distance. Integrating the data that they generate with data from other sources provides the foundation for the **Internet of Things** (IoT). The RFID becomes the bridge that connects the physical world with the information world [85].

Figure 1.3: Transponder

The IoT provides some huge potential, as well as risks for humanity. Applications have been already exploited or explored in the following areas: 1. logistics, e.g., RFID use by Walmart, 2. energy savings, e.g., GE locomotives equipped with multiple sensors can transmit large amounts of data and help improve efficiency. GE estimates that a 1% improvement in railroads could translate into $2.8 billion in savings annually [50], 3. physical security, safety, and privacy, e.g., surveillance of homes and buildings, cars that detect and respond to risky road conditions, 4. medical, e.g., clothes equipped with sensors monitor the vitals of senior people and send signals to doctors and caregivers in case of emergency.

Collectively the data generated by users in social media (Web 2.0) and smart objects in IoT (Web 3.0) is growing exponentially and has given rise to the term **Big Data** creating a problem regarding the cost of storing these data. Luckily, cloud computing provides a potential solution for cash conscious companies. Read the story of UPMC on p. 13.

Cloud Computing has been described as the delivery of computing as a service rather than a product [170] and encompasses any subscription-

[7] The RFID discussion is based on material from Bustillo [11], Gaither [44] and News [115].

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based or pay-per-use service that (in real time over the Internet) extends IT's existing capabilities [80].

Though you may not have realized it, you have been using cloud computing for a while. For example, if you have a web-based email account then you are using cloud computing. Cloud computing means that you can access the content of your email, i.e., inbox, sent mail, and contacts, from any computer that has a browser and Internet access. The content of your email is not stored in your phone or laptop. It is stored in the servers of the firm that provides the email service. Google documents is another example of cloud computing.

There are three main manifestations of cloud computing.[8]

Cloud computing - Infrastructure as a Service (IaaS): Vendors such as Amazon Web Services (AWS), Microsoft Azure, and VMWare provide clients with processing, storage, networks, and other IT infrastructure as a service. Clients use these computing resources to deploy and run their operating systems and applications. While the client does not manage or control the underlying IT infrastructure; the client has control over operating systems, applications, and possibly limited control of select networking components (e.g., host firewalls).

When it comes to big data, IaaS offers a solution which is cost effective and scalable to a company's needs [66]. Companies like UPMC - one of largest integrated non-profit health companies in US with over $10 billion in revenues - justify their cloud computing initiatives as follows [109]: "*...UPMC has about 5 PB of data today, and that volume is doubling every 18 months. So in about three years, it will have 20 PB of data, including medical images, genomic data and remote patient monitoring data.*[9] *[The firm's CIO] doubts that UPMC can afford to build enough conventional data center capacity to cope with that data. "My gut is we have to partner" he says. Partnering means UPMC buying infrastructure-as-a-service from vendors such as Amazon Web Services, Hewlett-Packard, IBM or Oracle so it doesn't have to spend tens of millions of capital dollars on data centers. Any of those vendors can provide the underlying hardware ...* "

[8]For a more detailed discussion on cloud computing read the National Institute of Standards and Technology - U.S. Department of Commerce report on cloud computing [105].

[9]As you read this quote you may wonder what the PB stands for. The answer is Petabyte. Which may prompt the next question: What does a petabyte look like? The article by McKenna [104] provides some very good examples. My favourite is the following one: *"If the average MP3 encoding for mobile is around 1MB per minute, and the average song lasts about four minutes, then a petabyte of songs would last over 2,000 years playing continuously."*

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Cloud computing - Platform as a Service (PaaS). Vendors provide clients with a platform - the IT infrastructure as well as operating systems or storage - as a service. The client can use the cloud platform to deploy their own applications and application hosting environment configurations. Unlike the IaaS, in the PaaS clients do not manage or control the underlying network, servers, operating systems, or storage. Clients have control over the deployed application.

Cloud computing - Software as a Service (SaaS). Vendors such as Salesforce.com, Amazon, Microsoft, Google, Oracle, Apple, and VMWare provide clients with applications running on cloud infrastructure. The applications are accessible through thin client interface such as a web browser. The client does not manage or control the underlying cloud infrastructure or application. However, clients have the ability to change certain configuration settings to tailor the application to their needs.

Firms are attracted to a technological solution like cloud computing that does not require a significant capital expenditure *(Why?)*. In addition to this, with cloud computing, firms do not have to worry about excess IT capacity when demand for the firm's products or services is slow or insufficient IT capacity when demand is high *(Why?)*. From an accounting standpoint cloud computing means that you convert fixed cost to variable cost (*explain why?*).

According to a CPA Canada and AICPA report [1] ***blockchain*** "... was first introduced as the core technology behind Bitcoin, the headline-grabbing decentralized digital currency ecosystem proposed in 2008. The appeal of blockchain technology lies in its use of peer-to-peer network technology combined with cryptography. This combination enables parties who do not know each other to conduct transactions without requiring a traditional trusted intermediary such as a bank or payment processing network.

By eliminating the intermediary and harnessing the power of peer-to-peer networks, blockchain technology may provide new opportunities to reduce transaction costs dramatically and decrease transaction settlement time. Blockchain has the potential to transform and disrupt a multitude of industries, from financial services to the public sector to health-care. As a result, a number of venture capital firms and large enterprises are investing in blockchain technology research and trials to re-imagine traditional practices and business models."

Visit projects like iota (https://iota.org/) ***to see how they envision a new world that leverages blockchain and IoT.***

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1.4 Technology Adoption

1.4.1 Innovation Adoption Life Cycle

When a new cell phone comes out do you want to be the first one to have it or would you rather wait until the price drops? The answer to this question indicates whether you are an early or late adopter of technology. In the previous section, we outlined several new technologies. Some of them have been around for several years, while others are at early experimental stage. Firms, like individuals, differ in their preferences and rate of adopting new technology.

It has been observed that adoption of new technologies by individuals or firms tends to follow an approximate bell shaped distribution, and the cumulative number of adopters over time resembles an S-shaped curve (See Figure 1.4).[10] Rogers [130] argues that the adoption of new technologies follows the bell shaped distribution because of the cumulative influence upon potential adopters from peer networks. In business terms, this means that it is the documented profitability and efficiency gains of early adopters that forces non-adopters to either follow in order to catch up or be in a position of competitive disadvantage.

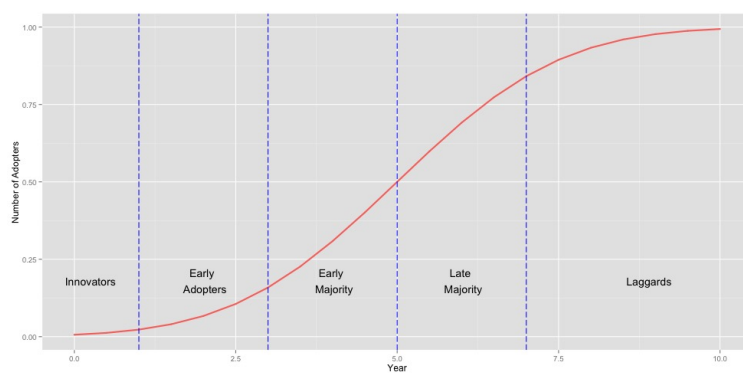

Figure 1.4: Rogers [130]: Cumulative Innovation Adoption

Using the properties of the bell shaped distribution (empirical rule),[11] Rogers [130] recommended the following five categories (see Figure 1.5):

[10] NB. The figure is based on hypothetical technology that has a mean adoption life of 5 years and a standard deviation of 2 years. It is just a visualization example!

[11] The empirical rule is one of the simplest and most powerful ideas in statistics. It leverages the mean ($\bar{x}$) and standard deviation (SD) of a normal distribution to predict

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innovators, early adopters, early majority, late majority, and laggards.

1. *Innovators* are the first to adopt an emerging technology. This means that they are prepared to take high risk. The adoption is associated with a high level of uncertainty, because the technology may not have been fully developed yet, and possible benefits may not be clear. Typically, *innovators* are in strong financial position so they can afford potential losses. Visually they are positioned to the far left of the normal distribution, i.e., to the left of $\bar{x} - 2(SD)$.
2. *Early adopters* though not as risk seeking as the *innovators*, they still have to deal with relatively high level of uncertainty. The technology is not at the experimental stage anymore, but this does not mean that it has reached a technological maturity yet. The role of *early adopters* is pivotal; their success will trigger the mass adoption, their failure means the end of the new technology. Visually they are positioned between $\bar{x} - 2(SD)$, and $\bar{x} - 1(SD)$.

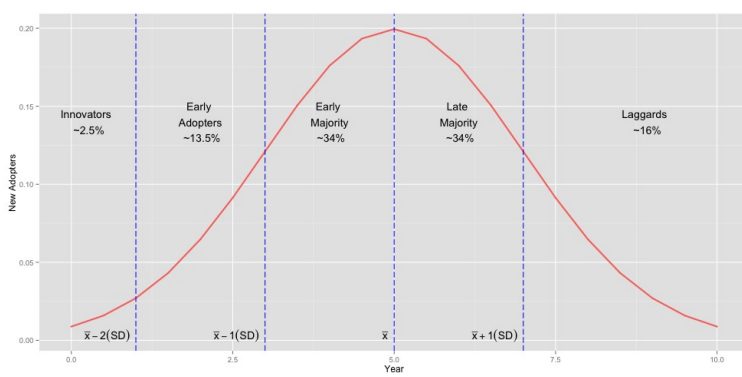

Figure 1.5: Rogers [130]: Classification of Adopters

3. *Early majority* will join the adoption process at the stage when most of the technology related risks have been mitigated, while the benefits of the adoption are still relatively high. Visually they are positioned between $\bar{x} - 1(SD)$ and $\bar{x}$.
4. *Late majority* reflects adopters who will invest in the new technology as a result of a strong peer pressure. From a business standpoint this means that the firm has already realized that its peers have gained

that approximately 68% of the observations will lie within $\pm$ 1 SD from $\bar{x}$, and 95% within $\pm$ 2 SD from $\bar{x}$.

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a competitive advantage, and investment in the new technology is a necessity. The firms has to invest in order to catch up with its competitors. Visually they are positioned between $\bar{x}$ and $\bar{x} + 1(SD)$.

5. There are several reasons while *laggards* behave they way they do. They may be simply hostile to new technologies, very conservative in their way they think and operate, or the role of the new technology in their operations may be tangential. Visually they are positioned to the right of $\bar{x} + 1(SD)$.

It should be emphasized that the above classification, its demarcations, and the percentages associated with it are not exact and they differ from one technology to another and across groups of adopters. Obviously the classification is only applicable in the case for successful technological innovations. There are many innovations that fail to go beyond the *innovator* or *early innovator* stage.

1.4.2 Technology Life Cycle (the Hype Cycle)

The Hype Cycle was developed by a Gartner, a technology consulting company, and is defined as follows [**gartner_hype_????**]:

> ... A Hype Cycle is a graphic representation of the maturity, adoption and business application of specific technologies. Since 1995, Gartner has used Hype Cycles to characterize the over-enthusiasm or 'hype' and subsequent disappointment that typically happen with the introduction of new technologies. Hype Cycles also show how and when technologies move beyond the hype, offer practical benefits and become widely accepted.

According to Gartner [48], the life cycle of nascent technologies, such as the Internet of Things (IoT), big data, and blockchain goes through the following five stages:

1. It starts with a technological breakthrough or a proof-of-concept, which triggers public interest in the new technology (*Innovation Trigger*). At this stage, the new technology is still at the experimental stage and no proven viable business applications have been developed yet.
2. This is followed by a period of unrealistic expectations (*Peak of Inflated Expectations*). Some companies start investing in the new technology.
3. Given that the technology is at an exploratory stage with no explicit and proven way to monetize it, the majority of the first generation of

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adopters fail to extract value from their investment and the initial hype is followed by disillusionment (*Trough of Disillusionment*). While, some of the developers and adopters exit, a hard core continue trying to improve the technology. Overall adoption of the new technology remains at less than 5%, and it corresponds, roughly, to *innovators* in Rogers' classification.

4. Gradually, new instances of how the new technology can deliver tangible benefits emerge, renewing the interest and spawning a new generation of adopters (*Slope of Enlightenment*). These adopters are the *early adopters* in Rogers' classification.
5. Their success, provides the proof that the technology is viable and generates benefits, thus mainstream adoption takes off (*Plateau of Productivity*). Rogers' *early majority* of adopters start implementing the new technology.

We need to keep in mind that the Gartner Hype Cycle is not based on hard evidence or scientific analysis. It simply represents the perceptions of Gartner analysts. The company updates the hype cycles on a regular basis. For example, in the 2017 hype cycle of emerging technologies (see Figure 1.6) blockchain was at the *peak of inflated expectations*. This means, that it would take between 5 and 10 years before the benefits to become unambiguous and the vast majority of firms start adopting. This period will be pivotal for several reasons:

First, developers and adopters that joined as a result of the bandwagon effect will exit leading to a consolidation of the market. Only the most serious contenders will continue investing time and resources in the development and adoption of blockchain. Second, major technological, policy, and business challenges will have to be addressed if blockchain is to achieve its full potential. Adopters will need to prove that leveraging blockchain is a value adding proposition. Third, players involved in addressing these technological, policy, and business challenges, will become the de facto leaders during the period of massive adoption.

1.4.3 A Methodology to Predict Adoption Time

Data analytics, big data, cloud computing, blockchain and IoT are just a few of the recent technological innovations. Since 2003, over 200 emerging technologies were identified by Gartner Inc.[150]. The rate of adoption of new technologies has significant implications for adopting firms, suppliers of these technologies, and investors. Some of these technologies have the

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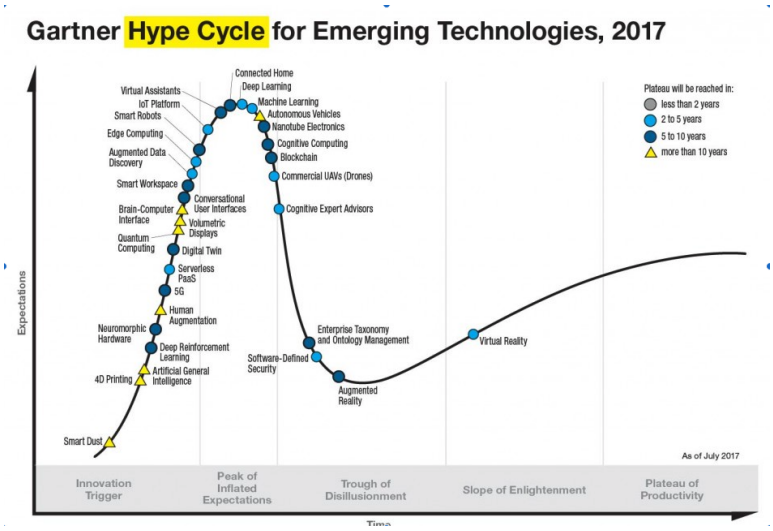

Figure 1.6: Gartner: Hype Cycle for Emerging Technologies

potential to disrupt the competitive landscape and provide adopting firms a competitive advantage.

Stratopoulos [150] argues that we can estimate the adoption time of an emerging technology by leveraging readily available technology, such as Google searches (available through Google Trends), news stories (through LexisNexis), book titles (through WorldCat), and a framework that maps hype cycle to adoption cycle.[12]

According to the adoption cycle, *innovators* are willing to adopt the new technology while still at the experimental stage. From the description of the hype cycle, we know that the new technology remains at the experimental stage during the *innovation trigger stage* and *peak of inflated expectation*s.

Given that the *innovator*'s adoption period reflects approximately one standard deviation in the adoption cycle, the time from the introduction of the new technology until the end of the *peak of inflated expectations* reflects approximately one standard deviation.

While *innovators* are willing to take high risk, *early adopters* will not

[12]Google Trends (`https://trends.google.com/trends/`) is a public service offered by Google that shows how often a specific search-term has been used relative to the total search-volume by geographic region and over time. The results, e.g., see Figure 1.7, are shown in a graph or tabulated. In the graph the horizontal axis represents time (starting from 2004), and the vertical axis is the relative popularity of the search term in a given geographic region and time frame.

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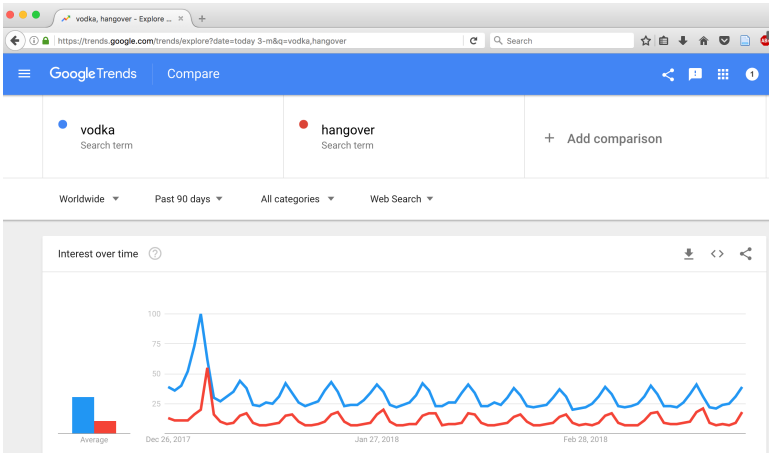

Figure 1.7: Google Trends: Search for Vodka vs Hangover

adopt until some of the technological uncertainty and business related uncertainty has been removed. Both of these kinds of uncertainty will start being mitigated as the technology goes through the *trough of disillusionment* and the *slope of enlightenment*.

Therefore, *innovators* and *early adopters* are likely to adopt the new technology up to the late stages of the *slope of enlightenment*. This means that the period from the introduction of the new technology up to the late stages of the *slope of enlightenment* reflects a period of approximately two standard deviations in the adoption cycle.

The adoption rate is likely to change due to several technological and economic factors. For example, the adoption of technology A is likely to slow down, if there is a new technology B that performs better than A. On the other hand the adoption of A is likely to accelerate, if it can serve as the foundation (prerequisite) for the adoption of a new lucrative technology C. Adoption rate is likely to accelerate when the technology is hitched to an economic bubble and/or bandwagon effect. Therefore, in cases that adoption is related to such factors, the first two stages of the hype cycle lets us predict two, rather than one, standard deviations in the adoption cycle.

The main premise behind an attempt to estimate the emerging technology's adoption cycle is that of establishing whether the technology would diffuse rapidly or slowly. There are several factors that would affect the shape of technology adoption. The most significant factor is potential adopters' expectations regarding the value adding contribution. The higher the per-

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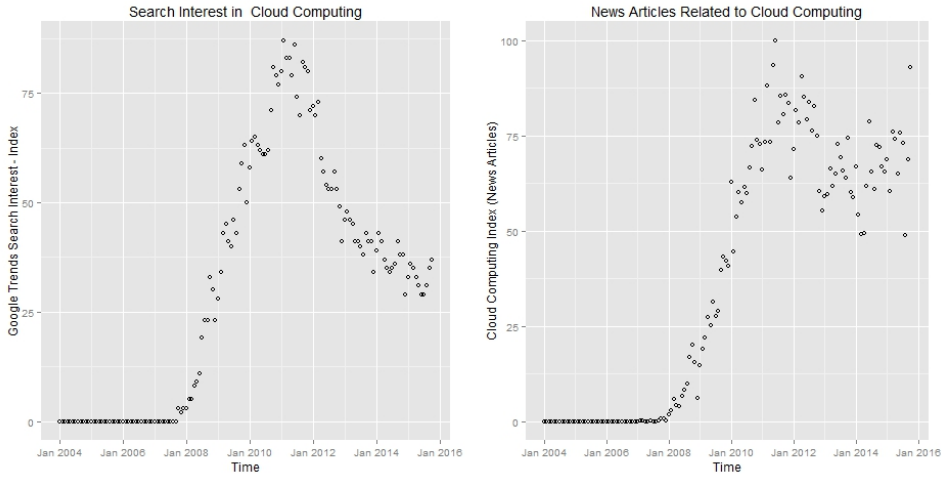

Figure 1.8: Cloud Computing: Google Trends and LexisNexis

ceived advantage by potential adopters, the faster will be the adoption rate.

Other factors include the perceived compatible with potential adopters needs, level of complexity in implementation of the new technology, ability to experiment with the new technology, and information or evidence regarding the implementation obstacles or factors that lead to higher success from existing adopters.

One would expect that the Google search interest would be positively correlated with the expected value of the emerging technology. For the generation of expectation proxy, we have used Google trends and the keyword "cloud computing." The Google Trends results (Figure 1.8 – left panel) show that, while cloud computing was introduced in the summer of 2006, the public started being interested in this in the fall of 2007. Interest has been rising in the following years, reaching its peak in 2011 and starting to decline by the end of the same year.[13]

The number of news stories has been suggested as another proxy for the future expected value of an emerging technology [40]. We used LexisNexis and focused our search to news stories where some variation of the term "cloud computing" appeared in the headline, highlights, lead paragraph or

[13]While Software as a service (SaaS) has been around since the late nineties; Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) are more recent. IaaS was 'formally' introduced with Amazon's introduction of Elastic Compute Cloud in August of 2006 [63].

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abstract of a story. The results shown in Figure 1.8 (right panel) show a similar pattern to the one from Google Trends, i.e., the number of new stories peaked in 2011.

Generating predictions regarding adoption time could be useful to financial managers trying to estimate the net present value of an investment in an emerging technology. The estimated duration could be used to discount net cash flows associated with this investment. The same estimation could be useful for investors and analysts trying to value the market reaction to a firm's decision to adopt the new technology. The estimated duration would be used to discount future earnings. Finally, it would be useful to the top management teams of firms supplying the new technology, as it would allow them to calibrate their strategy for the growth and maturity stage of their product's life cycle.

1.4.4 IT Adoption - Ethical Issues

As if dealing with the plethora of new innovations was not complex enough, some of them - like the RFID and use of big data - carry significant privacy implications and have people ponder ethical issues. As we have seen, Walmart was one of the first firms to adopt the RFID technology (p. 11). However, the first attempt to adopt in 2003, in addition to its usual technological complexities and generated some adverse publicity for Walmart. A blogger wrote: *... Starting this week, the nation's largest discount retailer will quietly begin selling tracking-chipped products to clueless shoppers. The first volley in their war against our privacy is set to start at their Brockton, Massachusetts store. ... But why start this in Brockton, Mass? Could it be because the store's customers are typically lower income minorities who'd be less likely to be aware of the tracking devices, and even less likely to make a fuss about them?* [147]

In July 9, 2003 Walmart canceled its RFID experimentation at Brockton. The firm resumed its efforts to implement RFID in 2010. However, the new adoption effort met with similar skepticism. *... In July 2010, news accounts stated that Walmart would soon be placing removable RFID "smart tags" on individual garments such as jeans and underwear in order to optimize stocking and inventory control procedures (and, if the results were promising, the company would eventually roll out RFID-tagging with other products as well). Privacy advocates responded by again raising concerns that the RFID technology could be used not just for inventory purposes, but for intrusive customer-tracking activities. ...* [143]

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Food for Thought

1. Obviously, these are the views of just two bloggers. Do you think that this is strong enough evidence to justify the cancellation of an RFID initiative? Could blogs like this, alter the payoffs from similar projects?
2. In March of 2018, CBInsights reported the results of a poll (see Figure 1.9).
   (a) Run a search to find out why Facebook performed so badly. (*Hint: run a search for news related to Facebook and Cambridge Analytica.*)
   (b) How did the market react to the unethical handling of personal data by Facebook?

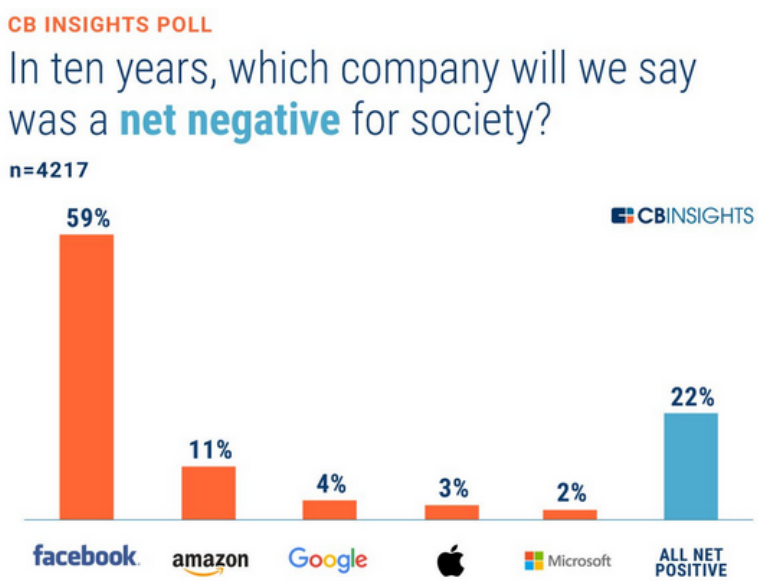

Figure 1.9: Tech Firms Effect on Society

1.5 Justifying IT Spending

1.5.1 IT Business Value Proposition

An idea taken from sciences, the Input-Process-Output model (I-P-O) - shown in Figure 1.10 - can be used in the context of IT spending to under-

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stand the link between IT spending and business value of IT. Inputs can be described as the business decisions and investments in relation to IT. The next step, process, represents the activities and decisions that convert the inputs into outputs.

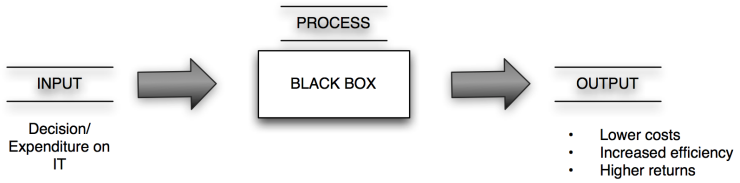

Figure 1.10: Input-Process-Output Model

The simplest way to justify IT spending is by looking at its expected effect on the firm's profitability. Knowing that profits are revenues minus expenses, one can try to classify IT spending as aiming to reduce cost or to increase sales. Historically, IT spending was considered as a way of automating manual tasks. However in most recent years, firms have realized that there are opportunities to increase revenues.

If you want to visualize an example about how IT investments reduce cost, consider payroll. It is one of the most common functions in all firms. Think about how the payroll would be generated with and without the use of IT. Prior to the introduction of computers, all calculations were produced manually. You can think of the introduction of spreadsheets as the first stage in the process of automating a firm's payroll. The next stage is the development of software applications that consider all firm and employee information (hourly pay, benefits, deductions), and use it to generate the firm's payroll. The direct effect of this investment is the reduction in the number of people needed to produce a firm's payroll. The indirect effects of automated systems are reduced time, reduced human errors (typos), and possibly an increase in employee satisfaction and productivity.

The effect of inventory management systems is another example. Inventory plays a dual role in the firm. Inventory is needed to meet a customer's needs. A firm cannot sell a product if the product is not available. Customers become irritated when they cannot find the product they want in stock. More importantly a customer who does not find what she wants is likely to visit a competing firm. This increases the chances that this customer may not come back. The simple solution to this problem is to increase the number of products and the quantity of each product that the

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firm holds in stock. However, carrying excess inventory means reduced liquidity because a higher portion of the firm's assets is tied down and does not generate profits. This is a very common inventory problem.

Investment in an inventory management system that integrates cash register (POS) with the firm's warehouse, can help a firm manage its inventory more efficiently and more effectively. It will allow the firm to have a better view of what is selling, what is in stock, and generate purchase orders as needed. The direct benefit in this case is that of reducing inventory cost (efficiency) and increasing sales or avoiding lost sales due to stock outs (effectiveness). However, there is also an indirect benefit. That is customer satisfaction. Happy customers are more likely to come back (customer loyalty) and provide more business (effectiveness).

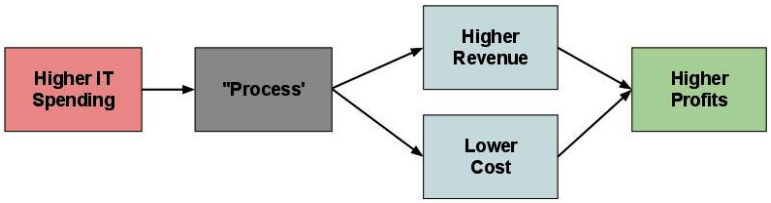

Figure 1.11: From IT Spending to Profitability

The above arguments and the story about the investment of Best Buy in sentiments analytics (see p. 11) seem straightforward and quite convincing. In their simplest form, they seem to indicate a positive association between IT spending and profitability. This positive association is known as the *Beautiful hypothesis* for IT spending, and is summarized on Figure 1.11. IT spending 'processed' (going through a ***black box***) leads to higher profits either through higher revenue or lower cost.

1.5.2 IT Business Value - Manifestations

While the business value of IT may seem straightforward; assigning a value to IT initiatives has been puzzling managers and researchers for the last 30 years, and the new generation of IT investments in business analytics has made this task more difficult [107]. In general, managers, investors, analysts, and researchers try to measure the payoffs from IT using the following three approaches: capital budgeting analysis, financial performance, and market valuation.

1. **Capital Budgeting**: IT spending means that the firm makes an IT

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investment because it expects either to raise its revenues or reduce its cost. Either one or both of these results will manifest in incremental cash flow. Therefore, if the project is successful it should generate a positive net present value (NPV).

2. **Financial Performance**: All else being equal, IT spending that increases sales or reduces cost should make the company more efficient and/or more profitable. Therefore, if the IT investment is successful it should manifest in higher profitability measures (e.g., gross profit margin and return on sales), and/or higher efficiency measures (e.g., asset turnover and inventory turnover).

3. **Market Valuation**: Investors buy stocks that are likely to generate high earnings in the future. If a company makes IT investments that have a positive NPV and produce relatively high financial performance measures, it signals to investors an ability to generate future earnings. Therefore, firms that make successful IT investments are more attractive and their market value (stock price) should be higher.

1.6 Payoffs from IT Spending - Part 1

The great tragedy of Science - the slaying of a beautiful hypothesis by an ugly fact. Thomas Henry Huxley

The seemingly obvious yet elusive relation between investment in IT and productivity, dubbed the **IT productivity paradox**, has been the center of numerous news articles, editorials, research projects and books. The spectrum of these studies ranges from the role of investment in IT on the economy, industry, and at the firm-specific level.

In 1987, in a New York Times Book Review, the Nobel laureate economist Robert M. Solow quipped that "you can see the computer age everywhere but in the productivity statistics."[144] This observation marks what is known as the IT productivity paradox. In other words, this quote was suggesting that we should take a second look at the *beautiful hypothesis* for IT spending. Given the way that the hypothesis was formulated, a logical test would be to look at the correlation between IT spending and profitability.

In a series of articles and books, Strassmann presents the results of his findings and the findings of several other studies based on firm level data [148, 149]. The conclusion he draws is that there is no identifiable association between expenditures on IT and profitability, and this relation has not

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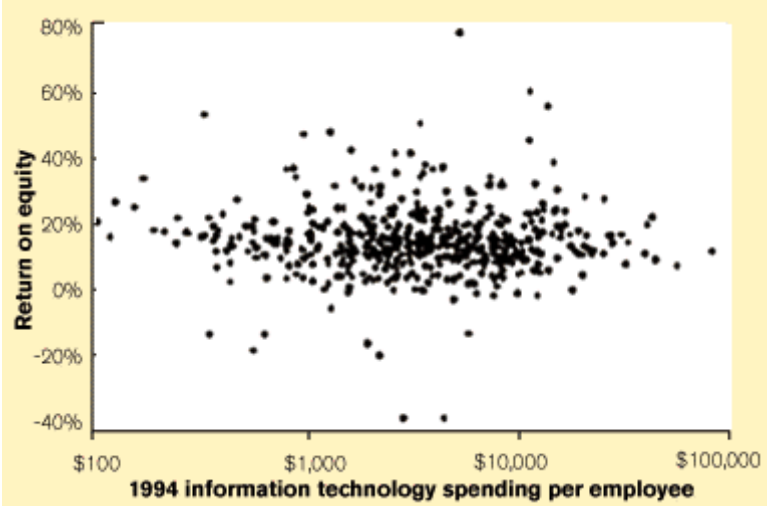

Figure 1.12: Strassman's Correlation Results

changed for more than 20 years. In his 1997 article [149], he summarizes the results of an analysis based on 292 companies. The scatter plot used to relate investment in IT and return on investment (ROI) reveals a random pattern (See Figure 1.12).

When Strassmann replicated his analysis using 1994 data for a group of 539 companies, the results were equally disappointing. The results do not change when he experiments with several different measures of profitability such as return on assets (ROA), ROI, and economic value added over equity. Segmenting his data set at the industry level did not improve the results. Strassmann [149] concludes that "[t]he relationship between corporate profitability and computer spending has not changed in more than 20 years. It is unlikely that any direct relationship between computerization and profitability will appear in the future."

As we will see in Chapter 3, a more recent study by Kobelsky et al. [81] has shown that there is a positive correlation between IT spending and profitability for IT capable firms. However, this does not mean that it as simple as it was originally assumed. Experienced business and IT professionals, as well as researchers, concur that maximizing the payoffs from IT investments requires planning.

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1.7 Summary and Concluding Remarks

In this first chapter we looked at IT from a business value standpoint. This means that we consider IT as an investment that an organization is making. Reviewing IT spending patterns over time and across industries shows that while IT spending constitutes a significant investment for all firms, certain industries spend more than others. As new technologies evolve, firms will continue investing in them expecting that this will help them reduce cost, increase sales, or both. While this argument sounds reasonable early empirical evidence has shown that this positive association between IT spending and firm performance should be not taken for granted.

Maximizing the payoffs from IT requires the development of a vision regarding the role of IT in the organization (IT strategy) that is aligned with the firms business strategy. We discuss business, IT strategy, and alignment between IT and business strategy in Chapters 2 and 3. Maximizing the payoffs from IT requires understanding the kind of investments firms make and why, evaluating their expected payoffs, manage risk during IT implementation and use in order to achieve the desired performance outcomes and accountable delivery of value, and planning for IT spending.

1.8 Practice Questions and Problems

1.8.1 Study Questions

1. What are the IT intensive industries?
2. Is IT spending lower before, during, or after a recession?
   (a) What additional clarification would you want to know before you answer this question and why?
   (b) Think about the demand and supply side aspect of this question. Hint: Suppliers are more likely to offer deep discounts during a recession. Why? Think about the bargaining power of buyers and suppliers during a recession.
3. Which industries spend the most/least and why? Hint: Think about the definition of IT and how this relates to the information content of the product/service offered by the industry
4. Why is IT spending lowest in Metals and Natural Resources?
5. Using descriptive statistics shown in Table 1.1, classify industries in high and low spenders.
6. What does it mean when the median is different than the mean?

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7. Stratopoulos and Lim [152] state that on average large North American firms spend $50 to $90 million per year in new IT products and services.
   (a) What are the limitations of this statement?
   (b) Estimate what percentage of the firms 2009 IT budget this represents for a firm from the Banking and Finance industry if the firm's annual revenue for the year was $700 million. Explain your finding and its limitations.
8. What is the difference between the recession of 2007-2009 and the recession of 2001? What was the role of IT? *(Hint: Read the article by Spang [145] quoted on the note on p. 10.)*
9. The discussion in section 1.4.4 (p. 22), raises some ethical issues associated with RFID adoption. These are the views of two bloggers. Do you think that this is strong enough evidence to justify the cancellation of an RFID initiative? Could blogs like this, alter the payoffs from similar projects? What issues would you want to consider? Explain.
10. How does Best Buy (see page 11) know who the most profitable and influential customers are? If you are a competitor of Best Buy is there anything that may hold you back from implementing similar investment in sentiment analytics? Is time delay such a factor? Why?
11. Is cost cutting a viable long-term strategy? Explain why.
12. If the expected average adoption of a new technology is three years and the standard deviation is one year:
    (a) What percentage of firms would adopt the new technology in the first two years?
    (b) What percentage of firms would adopt the new technology after the fourth year?
    (c) What percentage of firms would adopt the new technology after the first year but before the third year?
13. What statistical method will you use to capture the association between IT spending and profitability? What is the highest value of a positive association? What is the lowest value of a negative association?
14. What is the beautiful hypothesis for IT spending?
15. Strassmann [149] "... Computers are only tools. They are not an unqualified blessing. Identical machines with identical software will perform admirably in one company but will make things worse in an enterprise that has inferior management. They enhance sound business practices. They also aggravate inefficiencies whenever the people

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who use them are disorganized and unresponsive to customers' needs. The best computer technologies will always add unnecessary costs to a poorly managed firm. The problem seems to rest not with the inherent capabilities of the technologies, which are awesome, but with the managerial inability to use them effectively. ... Unless robots end up running completely automated businesses, the relationship between computerization and profitability will remain a random scatter diagram for many years to come."

(a) Do you agree with this statement?
(b) What does it mean?
(c) How does this statement relate to the black box in Figure 1.11?

16. What are the methods for assigning value to IT initiatives? Are these methods forward/backward looking?

1.8.2 Multiple Choice Questions

1. On average large North American firms tend to spend ___ of their total revenue on IT.

   (a) 6-8%
   (b) 4-6%
   (c) 1-2%
   (d) 2-4%

2. According to the analysis done by Strassmann

   (a) There is a very strong positive correlation between IT spending and ROE
   (b) There is a positive but not strong correlation between IT spending and ROE
   (c) There is no correlation between IT spending and ROE
   (d) There is a strong negative correlation between IT spending and ROE

3. Under current accounting rules, firms ...

   (a) are required to report only IT spending for new investments
   (b) are required to report IT spending on new projects as well as maintenance and support
   (c) are required to report only IT spending for maintenance and support
   (d) are not required to report IT spending

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4. If a firm's IT spending as a percentage of revenues was 4% in 2011 and 5% in 2012,
   (a) there is not enough information to safely conclude about the amount the firm spent on IT.
   (b) we can safely conclude that the amount spent on IT increased in both years.
   (c) we can safely conclude that the amount spent on IT increased in 2011.
   (d) we can safely conclude that the amount spent on IT increased in 2012.
5. If we were to rank industries in terms of IT spending as a percentage of their revenues we should expect that on average ...
   (a) Mining and natural resources related firms spend more than telecommunication firms.
   (b) Logistics and transportation firms spend more that banking and finance firms.
   (c) Consulting and business service firms spend less than manufacturing firms.
   (d) Information technology firms spend less than banking and finance firms.

1.9 Business Analytics Practice Problems

1.9.1 Amazon and Cloud Computing - Market Reaction

Amazon introduced cloud computing around 2006. According to Stratopoulos [150] cloud computing became a main steam technology around 2014-15.[14]

1. Extract weekly stock market data for Amazon from 2001-2016.
2. Create a graph showing adjusted closing price of Amazon during this period.
3. How did the market react to Amazon's cloud computing initiatives. Please, keep in mind that there are numerous other factors that affect the price of Amazon. What you are hoping to capture is an overall trend.
4. Extract the S&P500 data for the same period. Merge the two data sets and create side-by-side graphs for Amazon and S&P500.

[14] The solution for this practice problem is on p. 33.

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5. The period from 2007 to 2009 is the period of the financial crisis. Focus on this period (create a subset that captures the period 2007 to 2010) and plot side-by-side graphs for Amazon and S&P500. What is the main message from these graphs?

1.9.2 Apple and Blackberry: Market Reaction to iPhone

The objective of this exercise is to compare the effect of the introduction of iPhone on Apple and Blackberry. Apple introduced its iPhone in the summer of 2007.

1. Extract weekly stock market data for Apple and Blackberry from 2001-2016.
2. Create a graph showing adjusted closing price of Apple during this period.
3. Tell a story (about a paragraph) based on your results.
4. Create a graph showing adjusted closing price of Blackberry during this period.
5. Tell a story (about a paragraph) based on your results.

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1.10 Solutions to Selected Practice Problems

1.10.1 Amazon and Cloud Computing - Market Reaction

Extract stock market data for Amazon and create a graph.

```
library(quantmod)
Sys.setenv(TZ = "UTC")
getSymbols("AMZN", src="yahoo", periodicity="weekly",
from=as.Date("2001-01-01"), to=as.Date("2016-12-31"))
names(AMZN)
nrow(AMZN)
head(AMZN,3)
tail(AMZN,3)
plot(AMZN[,6])
```

Extract stock market data for S&P500.

```
getSymbols("^GSPC", src="yahoo", periodicity="weekly",
from=as.Date("2001-01-01"), to=as.Date("2016-12-31"))
names(GSPC)
nrow(GSPC)
head(AMZN,1); head(GSPC,1)
tail(AMZN,1); tail(GSPC,1)
```

Combine the two data sets.

```
dt1 <- cbind(AMZN[,6], GSPC[,6])
head(dt1,3); tail(dt1,3)
nrow(dt1)
names(dt1)
names(dt1)[1:2] <- c("AMZN", "SP500")
names(dt1)
```

Create side-by-side graphs for Amazon and S&P500.

```
par(mfcol=c(1,2))
plot(dt1$AMZN); plot(dt1$SP500)
par(mfcol=c(1,1))
```

Focus on period that encompasses the financial crisis (2007 to 2010) and create side-by-side graphs for Amazon and S&P500.

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```
dt2 <- dt1['2007-01-01::2010-12-31']
par(mfcol=c(1,2))
plot(dt2$AMZN); plot(dt2$SP500)
par(mfcol=c(1,1))
```


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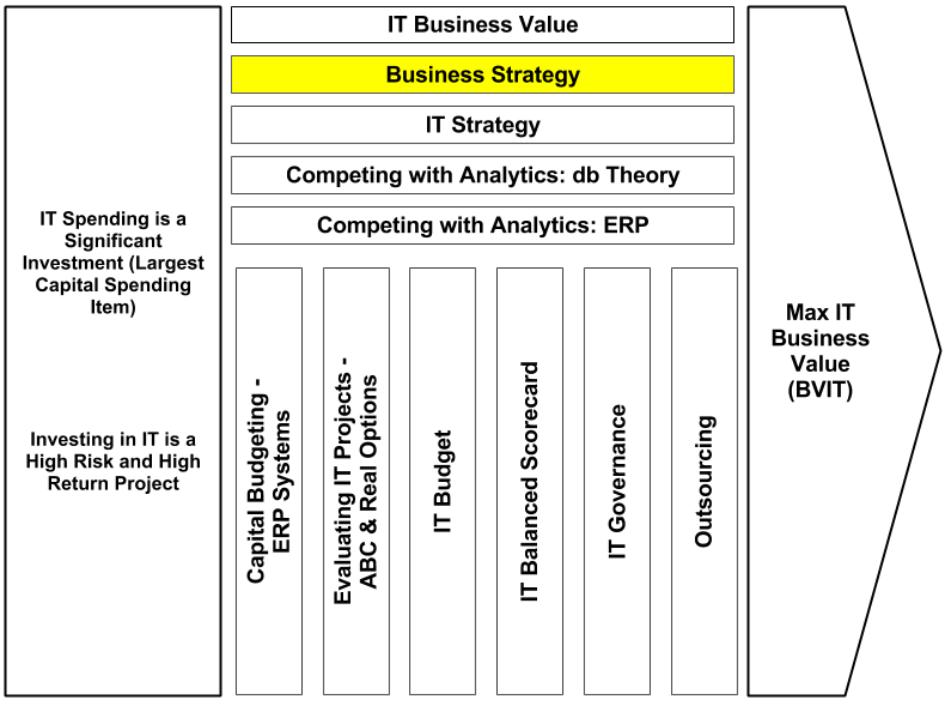
Chapter 2

Business Strategy



Theophanis C. Stratopoulos, University of Waterloo

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News Based Context and Perspective

As you read the news stories about BlackBerry, think about the following two questions: Why does RIM (since 2012 the company changed its name to BlackBerry) want to become a smaller, leaner, and more focused firm? What are the implications of this strategy for the firm's financial performance?[1]

In March of 2012, *The Waterloo Region Record* published an article about the BlackBerry's strategy to become a smaller, leaner, and more focused firm. The author of the article, LaSalle [87] writes that ... *After releasing dismal quarterly results on Thursday, the BlackBerry maker announced plans to rebuild itself, while opening the door to the possibility it would consider a host of corporate options ...*

LaSalle [87] reports: ... *New CEO Thorstein Heins told analysts late Thursday that RIM will shift more attention to its business users and will go after only "targeted" parts of the consumer market, possibly with partners. "We plan to refocus on the enterprise business and capitalize on our leading position in this segment," ... RIM could license its popular texting service, BlackBerry Messenger, and the encryption technology that gives its BlackBerrys security. "Who do you think of when you think of secure communication?*

LaSalle [87] continues ... *RIM's stock price hit a lofty high of almost $140 per share in 2008, only to see it fall as Apple and Android smart phones made inroads and won over consumers with fun and easy-*

[1]Source of the BlackBerry phone: http://ca.blackberry.com/smartphones.html, source of Android phone: https://www.android.com/phones/, source of Apple iPhones image: http://store.apple.com/ca_consumer_340760/buy-iphone/iphone6google

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to-use software applications. LaSalle [87] closes the article by pointing to the fact that analysts are not convinced that this new strategy would succeed because BlackBerry is ... *focusing on its enterprise roots, which is not the fastest growing market.*

A 2015 update in the New York Times [171] reports that ... *BlackBerry is in the midst what it calls a two-year turnaround plan, ... as it focuses more on mobile software and security offerings. To that end, John S. Chen, the BlackBerry chief executive, focused much of his presentation on BlackBerry's shift from a pure device maker to a company that can power business services on a variety of devices ...*

On March 22, 2018 Bloomberg [162] reported that BlackBerry added Jaguar to its roster of automaker partners. "*The deal is the latest BlackBerry has trumpeted over the last year as it seeks to expand its QNX car software unit from in-car entertainment systems to other realms of auto software, including self-driving technology.*"

BlackBerry has signed similar deals with Ford, Qualcomm, Baidu, and Nvidia. The article concludes that "*Though car software is still a relatively small part of BlackBerry's business, it's becoming an important growth area. After jettisoning the smartphone unit due to shrinking sales, Chen has worked to shift the Waterloo, Ontario-based company's focus onto secure software for a range of different businesses.*"

The stories about BlackBerry provide the backdrop for the material on business strategy and its implications on financial performance. Companies like BlackBerry respond to strategic actions taken by their competitors. If they are successful, this will be translated in superior financial performance. The ultimate goal for all firms is to develop and implement a strategy that will set them apart from their competitors, i.e., give them a competitive advantage.

Learning Objectives

By the end of this chapter, students should be able to describe, interpret, and apply the following concepts:

- Firm performance (absolute versus relative performance) and perfor-

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mance measures (economic versus accounting measures)
- Business models
- Industry structure view
- Resource based view
- Value chain
- Porters archetypes of business strategies
- Financial performance measures related to market structure and business strategy

2.1 Introduction

Sustainable competitive advantage, is the holy grail of strategic management. It reflects a firm's ability to resist competitor's attempts to imitate or improve on the source of its competitive advantage [4]. Achieving a sustainable competitive advantage is not an easy task. In the case of Apple it took a series of successive innovative ideas which were converted into products that customers want, such as the iPod, iTunes, iPhone, iPad, and Apple Pay. While, firms like Apple, continuously seek to develop new competencies by renewing, replicating, redeploying, or recombining their capabilities; competitors like Samsung, Google and BlackBerry constantly seek to seize and improve these competencies or initiate new ones. For every successful company there are numerous competitors in a relentless pursuit to upstage the current leader.

In strategic management, relative performance is very important. Managers and stakeholders constantly evaluate their position relative to their direct competitors. From a relative performance standpoint a firm's competitive position can be classified as being in **competitive advantage**, **competitive parity**, or **competitive disadvantage**. When we refer to competitive advantage, we need to make the distinction between sustained versus temporary competitive advantage.

Specific actions that firms take to neutralize threats or exploit opportunities by leveraging their resources and capabilities in order to gain a competitive advantage within a particular market or industry are known as **business strategies**. On the other hand firm actions that aim to gain a competitive advantage across several markets or industries are known as **corporate strategies**. The focus of this chapter is on business strategy and factors that shape a firm's business strategy. From a technology standpoint, understanding business strategy is very important because the business value of technology investments depends on the firm's ability to align

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its IT initiatives with its business strategy.

2.2 Relative Firm Performance

The foundation of relative performance measures is in micro-economics, and the use of the terms normal and economic level of profits. The normal level of profits (or zero economic profits) represents the minimum level of profits that a business owner would consider necessary in order to make it worthwhile to run the business. In economic terms, this refers to the level of profits that covers the cost of all inputs, as well as the owner's opportunity cost.[2] A firm that earns just normal profit is a firm in competitive parity.

If a firm competes in a market that has the following characteristics: many companies of more or less the same size, using similar technology and resources, and selling similar products, the firms has no option regarding the price it charges. If the company wants to survive in this market, it must charge the same price like all other firms. As a result the firm will generate just normal level of profits (zero economic profits). We say that this firm competes in a perfectly competitive market.

On the other hand, (positive) economic profit means that the firm generates revenues which are above the opportunity cost of the firm's inputs. Therefore a firm that earns economic profit is a firm that has a competitive advantage. A firm can achieve positive economic profits, if it can differentiate its product and charge a higher price or operate at a cost that is lower than its competitors. Typically, these firms operate in monopolistic or oligopolistic markets.

While economic profit is a theoretically sound measure of relative performance, it is not very practical, because it is based on the assumption that we can measure opportunity cost for all resources used by a firm. In lieu of economic profits, stakeholders use accounting profits. The primary advantage of using financial accounting ratios is that they are readily available. Their two main limitations are that they provide a measure of past performance, and they don't account for risk.

Accounting measures of performance are divided into three groups - efficiency, cost, and profitability. They provide a view in terms of the firm's ability to leverage its assets (*Efficiency measures*) and contain its cost (*Cost measures*) in order to achieve a desired level of profitability (*Profitability measures*). The most common profitability measures are return on assets (ROA) and return of equity (ROE), as well as the variations of profit margin

[2]Opportunity cost is what the owner could have earned doing the next best job.

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(e.g., gross, operating, and net profit margin). The list of efficiency measures includes such ratios as asset and inventory turnover, as well as sales or income per employee. The two most common cost measures are focusing on cost of goods sold and operating expenses. See Appendix B.1 (pp. 303-307) for a list of commonly used accounting performance metrics and how to calculated them using Compustat data.

Investors and strategists have been looking for performance measures that bridge the gap between purely economic measures and accounting measures. Economic value added (EVA), market value added, return on invested capital, and Tobin's q are some of these measures, which are known as hybrid measures. The calculation of hybrid measures requires use of advanced finance and accounting theories and concepts. One of the most commonly used hybrid measures is (Tobin's q). Conceptually, it specifies the firm's market value as a multiple of the replacement cost of its assets. For example, if a firm has a assets worth $100,000 and the market value of the firm is $500,000, this means that the firm has been able to generate value from its assets. The firm has been able to achieve above normal performance level. A value of Tobin's q above 1.0 indicates that the market believes that the firm is able to generate (positive) economic profits, i.e., it has a competitive advantage. See Appendix B.1 for directions on how to estimate Tobin's q with Compustat data.

The discussion on relative performance measures raises the question: What makes some firms more successful than others? What tools do companies leverage in order to succeed in their quest for superior performance?

2.3 Business Models

In our quest to understand and explain forces that shape business strategy, we will start with business models.[3] A business model is like a story that tries to explain how the firm will make money. For example, a business model defines how the firm delivers value to its customers, entices customers to pay for value, and convert these payments into profits.

While it is relatively easy to come up with a business model, a successful one, like the proverbial mousetrap, should be either better than the existing one or cover some unique need of a specific group of customers, or replaces completely the need of a mousetrap.

There is a plethora of business models that can be designed and employed, and some are more successful than others. Read the SideNote: The

[3]The discussion on business models is based on the following sources: [3, 16, 92, 155]

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Business Model and Strategy of Walmart (p. 42). Walmart, Dell, and Southwest Airlines are some of classic examples of companies known for their successful business models.

Walmart started by modifying the traditional discount retail model. It chose to focus on inventory management in order to offer branded goods for less to a targeted group of customers. Dell became famous for its supply-chain management, and Southwest for its short haul low fare business model. New companies like Skype and LinkedIn, which could not have existed without IT, have developed new business models such the 'freemium' based business model.

According to Sarrazin and Sikes [132] *Companies like LinkedIn and Skype have thrived using the "freemium" model. Both cultivated a large base of users with their basic, no-cost platform, and then introduced several paid-for options, ranging from recruiting services and tiered access and networking privileges in the case of LinkedIn and landline calling in the case of Skype.*

Designing a good business model is in part an art. However, one can increase the chances of success by building a business model based on research that aims on the following two points:

1. Understand your potential customers and their needs.
2. Analyze your operations and make sure that you can deliver what the customers want (effectiveness) and when they want it (timeliness) at a reasonable cost (efficiency).

The need to incorporate both of these views is apparent when you consider the following formal definition of a business model: *A business model defines how an enterprise interacts with its environment to define a unique strategy, attract the resources and build the capabilities to execute it, and, in the process, create value for all stakeholders. A successful business model aligns an organization with its environment* [3, p. 26].

In the following paragraphs, we will focus first on a theory that helps us evaluate the external environment within which a firm operates (2.4) and then on theories that would help us understand the firm's internal environment, i.e., its resources and capabilities (2.5).

2.4 Role of Economic and Industry wide Forces

'*Other people are my hell.*' Jean Paul Sartr

According to Porter [121, 122] managers who want to position their company to cope best with its industry (**neutralize threats**) or to influence

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that environment in the company's favor (**exploit opportunities**) must learn what makes the environment tick.

SideNote: The Business Model and Strategy of Walmart

The discount-retailing business model was based on the idea of applying supermarket logic to the sale of general merchandise. Customers are willing to give up personal service and serve themselves, in exchange for lower prices. While Sam Walton based his original business model on existing retailers, namely Kmart, he made several changes that made it unique and more aligned with its environment.

Figure 2.1: First Walmart (from Wikipedia)

1. He chose to target a different group of customers in a different set of markets. While all large retailers of his time focused on large metropolitan areas, Walton chose to put his stores in small and relatively isolated towns with populations 5,000 and 25,000. His argument was that if he could match or beat prices that retailers offered in metropolitan areas, customers would rather shop locally. The additional advantage of choosing small towns was that they were too small to support more than one large retailer.
2. Walmart took a different approach to merchandising and pricing. While most of the retailers at that time chose to offer private label goods, second tier brands, and price promotions, Walmart promised national brands at its quintessential *everyday low prices*.
3. In order to succeed on its business strategy the company made efficiency and cost reduction through innovation in purchasing, logistics, and information management its top priority.

Porter's **Industry structure** or **Porter's five forces** framework is used to perform industry analysis and for business strategy development. Porter

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proposed that the following five forces determine the competitive intensity and therefore **attractiveness of a market**:

1. Threat of new entry
2. Rivalry among existing competitors
3. Bargaining power of buyers
4. Bargaining power of suppliers
5. Substitute products

Attractiveness in the context of industry structure, refers to the overall industry profitability. An industry is unattractive, if the combination of these five forces drives down overall profitability in the industry. Perfect competition is an example of an unattractive industry. Recall that economic profits are equal to zero in a perfectly competitive market. On the other hand a monopoly is an attractive market because the monopolist faces no competition and customers have no options, i.e., there are no close substitutes. In the following paragraphs we will explore Porter's five forces and their effect on industry profitability.

2.4.1 Threat of New Entry

When a company like Apple enters the cell phone industry, Google enters the text editing industry, or Amazon enters the supermarket industry, they are bound to clash with existing companies, as they vie for market share. This forces profitability in the industry down. The higher is the threat of new entry in an industry, the lower the attractiveness of the industry. According to Porter there are seven sources of entry barriers that work in favor of incumbent firms.

1. Economies of scale. This refers to the fact that some firms have an advantage due to size. The advantage typically manifests in the firm's average cost per unit, which tends to drop (up to a point) as the volume of the firm's output is rising. The simplest explanation is associated with the firm's ability to spread its fixed costs over a larger volume of output.

2. Demand side benefits of scale (network effect). How much would you be willing to pay for a phone, if none else uses a phone? Would you use email or Facebook, if none of your friends or colleagues was using it? Obviously, in cases like these, the value of the product or service that you consume increases with the size of the network of users. Google has discovered, that this is a powerful entry barrier. Google's attempts to enter the social network market, with Google+, have not been successful because Facebook enjoys a very strong network effect. As we have seen (p. 41), companies like

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Skype and LinkedIn have used the 'fremium' model to generate the necessary critical mass of users that provides them with the advantage of the network effect.

3. Customer switching costs. This is the cost that existing customers will have to incur in order to switch to another provider. This may be explicit, as in the case of cell phone providers. The cost of breaking a 3-year contract may be several hundred dollars. On the other hand, the cost of switching from TurboTax to another tax preparation software is implicit (inconvenience of re-entering all of your personal information).

4. Capital requirements. If a new player wants to enter the product market and compete against the average firm in the industry, it will have to make an investment in property, plant and equipment. The industry-average size of plant and equipment is considered as a proxy measuring the setup costs that a new player will be facing. Similar effect is captured by looking at the industry-average R&D and capital expenditures.

5. Incumbent advantage independent of size. A patented technology has the potential to provide a firm with a monopolistic power.

6. Access to distribution channels. A firm that makes a superior product is doomed to fail unless it can figure out a way of making this product available to consumers. Obviously, if incumbent firms control existing distribution channels the new entrant is facing an entry barrier.

7. Government policy. The most common example is that of firms producing defense related products. Several governments consider the development of defense industry a national priority. Existing firms are supported by generous subsidies and preferential treatment in government contracts.

- See Appendix C.1 (p. 309) for accounting proxies of barriers to entry based on Compustat data.

Another implicit barrier to entry is past reaction of incumbents to new entrants or expected reaction of incumbents to new entrants. The more aggressive is the retaliation of incumbents, the higher the barrier to entry. Factors such as market growth and incumbent's capital structure may determine the reaction of incumbent firms.

2.4.2 Rivalry Among Existing Competitors

Existing competitors may use several competitive actions to initiate a competitive attack or respond to an attack by a competitor. These kinds of actions are advertising, price discounts, new products, new features on existing products, or new services. The higher the rivalry among existing

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competitors the lower the overall profitability. In general, we expect the following associations:

1. Intensity of rivalry increases with the number of existing competitors. As an extreme scenario, you may want to consider perfect competition. Remember that in micro you have described perfect competition as a market with a very large number of small players.
2. Intensity of rivalry is a function of industry growth. If the market is not growing any more, companies that want to grow have no other option but taking market share away from existing competitors.
3. Intensity of rivalry is a function of exit barriers. If existing firms have no viable option for immediate exit from the industry, they adopt the mentality of 'I have nothing to lose' and are more likely to engage in destructive price wars.
4. Intensity of rivalry is a function of rival's commitment to the business. Companies committed to their line of business are more likely to defend their position by all feasible means.

Among all forms of competitive reaction, price competition is the most destructive to industry profits. Firms are more likely to engage in a price based competition, if the following conditions are met:

- products are commodity like
- firms have high fixed cost
- products are perishable

Food for Thought: Are air-plane seats on a certain route/date perishable?

- See Appendix C.2 (p. 310) for accounting proxies of rivalry among existing competitors based on Compustat data.

2.4.3 Power of Buyers

Buyers may be able to negotiate the price or the quality of the products/services that they buy from the industry. The higher their power to negotiate, the stronger is the downward pressure on the level of profits in the industry. Naturally, factors that increase the power of suppliers reduce the power of buyers and vice versa. The power of buyers relative to the industry is a function of the following:

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1. Number of buyers. If there is a small number of buyers that can collectively buy from their supplier, they can increase their bargaining power.
2. Nature of the product. If the products that the industry produces (what customers buy) are not differentiated the bargaining power of buyers is higher.
3. Switching costs. The bargaining power of buyers is higher if they face no switching costs.
4. Backward integration. If buyers can credibly threaten to **integrate backward** their bargaining power rises. For example, if HP threatens to start making its own computer chips - to the extent that this is a credible threat - HP increases its bargaining power versus Intel and AMD.
5. Importance of product for buyer. If industry product is not significant to the quality of the buyer's product or service the bargaining power of buyer is increasing.

2.4.4 Power of Suppliers

Suppliers may be able to raise the price of inputs or lower the quality of these inputs and this will drive the profits down in an industry that is unable to pass this cost to its customers. The bargaining power of suppliers is a function of the following:

1. Number of suppliers. If the number of suppliers is small (oligopoly), they are less likely to directly compete with each other.
2. Nature of suppliers' product. If the product is unique or differentiated and/or there is no substitute, suppliers are less likely to feel the pressure to reduce the price of their products.
3. Ability to forward integrate. If a supplier can credibly threaten to **integrate forward**, i.e., start producing the product that uses part of its input, the customer will lose its negotiating power. An example of forward integration is that of Intel making and selling its own computers. In such a situation the supplier becomes a competitor.
4. Percentage of suppliers sales coming from a specific industry. If the percentage is small, the industry is not an important customer. The supplier has no incentive to offer preferential pricing or discounts.
5. Suppliers know that industry participants face substantial switching costs. Therefore, the bargaining power of buyers is small.

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2.4.5 Threat of Substitutes

A substitute is a product or service that performs the same or similar function as the industry's product or service but through different means. For years salespeople have traveled to the location of client to accommodate face-to-face meetings. You may be familiar with the term road-warrior. Business related traveling is a lucrative market for airlines. Technological innovations, such as video conferencing via Skype offer a more economical alternative for cash strapped companies, but they reduce the demand for airline tickets and as results the profitability of airlines.

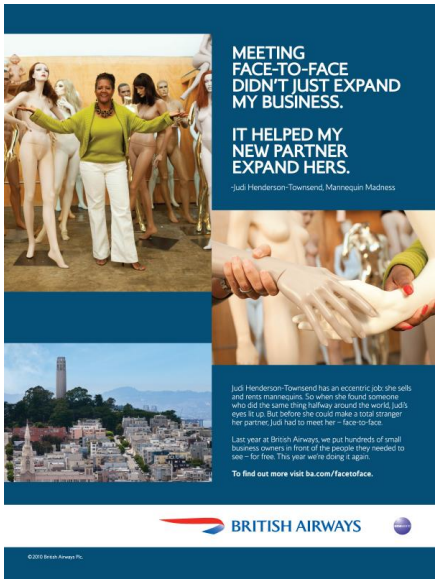

Figure 2.2: BA Ad

Several airlines felt this pressure and tried to push back by emphasizing the importance of a face-to-face meeting and a handshake. British Airways run a series of adds with this theme. One of their adds from the print edition of the Economist (September 11, 2010) is shown in Figure 2.2. Another add run with the caption "Ever shaken phones on deal? It's better to be there. British Airways."

In general you may want to think out of the box, when you consider substitute products. For example, it is relatively easy to see why or how a a cell phone could serve as a substitute for a watch, but what about eating out? (*Read question 16 on page 61.*)

- See Appendix C.3 (p. 313) for a discussion on accounting proxies of product substitution based on Compustat data.

2.4.6 Implications of Five Forces Framework

Performing the due diligence in terms of industry analysis means that the management of the firm understands how the competitive forces affect the profitability of the industry, and develop a strategy to improve the firm's

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performance. Theoretically, a firm's strategists should try to position the firm in attractive markets, where competitive forces are weak.

Given that a firm may not have the freedom to reposition itself in a new industry, the management should try to either exploit changes in the competitive forces or try to influence these forces to the firm's advantage (see Figure 2.3). The stand that a firm takes towards these forces may be defensive (try to neutralize a threat) or offensive (try to exploit an opportunity).

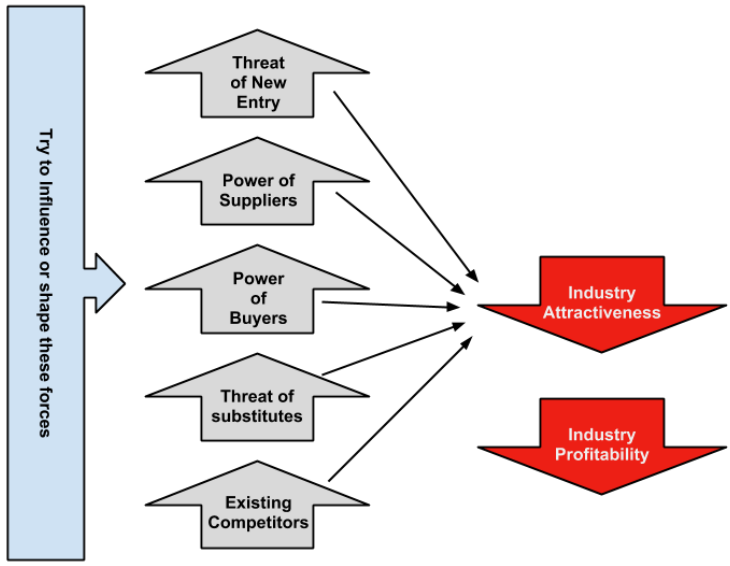

Figure 2.3: Porter's five forces

Analysis of the industry structure will reveal the level of competitive intensity within the industry. For a firm that operates in an unattractive industry, the following two options may be desirable:

1. Firms can neutralize their competitors' strength simply through imitation.
2. Firms can neutralize their competitors' strength by identifying a new segment and serving new customers who have a different value system.

Limitations of Porter's Five Forces Porter's five forces framework has inherent weaknesses in dynamic environments.[4] The concept of an industry

[4]For a more detailed discussion see Teece [155].

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is itself of questionable value, and if industry boundaries exist, they are faint. This is particularly important in technologically advanced environments. For example, consider the boundaries of the music industry before i-tunes, book industry before Amazon's Kindle, phone industry before Skype and Vonage.

2.5 Resources and Capabilities

Recall that a business model defines not only how a firm interacts with its environment to define a unique strategy, but also on how the firm attracts the resources and builds the capabilities to execute its business strategy, and, in the process, create value for all stakeholders. Therefore strategists need to understand resources, capabilities and knowledge that the firm has, or needs to acquire/develop, in order to deliver what the customer wants in a cost-effective and timely fashion. In the following sections, we will look at two theories that support such an evaluation of the firm's internal ecosystem. More specifically we will review Porter's Value Chain analysis and the Resource Based View.

2.5.1 Porter's Value Chain Analysis

A value chain is a chain of technologically and economically distinct activities that a firm performs in order to do business in a specific industry (see Figure 2.4). These activities are called **value activities**. The value chain analysis is based on the idea that firms must create value in the products/services they sell. The value a company creates is measured by the amount that buyers are willing to pay for the firm's product or service. Therefore, a firm is profitable, if the value it creates exceeds the cost of performing the value activities. A firm has a competitive advantage over its rivals, if the company can perform these activities at a lower cost or perform them in a way that leads to differentiation and a premium price (more value).

The value chain categorizes the value-adding activities that a firm performs into **primary activities** and **support activities**. Primary activities are those involved in the physical creation of the firm's product, its marketing and delivery to buyers, and its support and servicing after the sale. The list of primary activities includes inbound logistics, operations (production), outbound logistics, marketing and sales, and after sales service and support.

Every activity employs purchased inputs, human resources, and a combination of technologies. Support activities provide the inputs and infrastructure that allow the value activities to take place. The list of support

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activities include among others human resource management, firms infrastructure (accounting, legal, general management), information technology, R&D, and procurement.

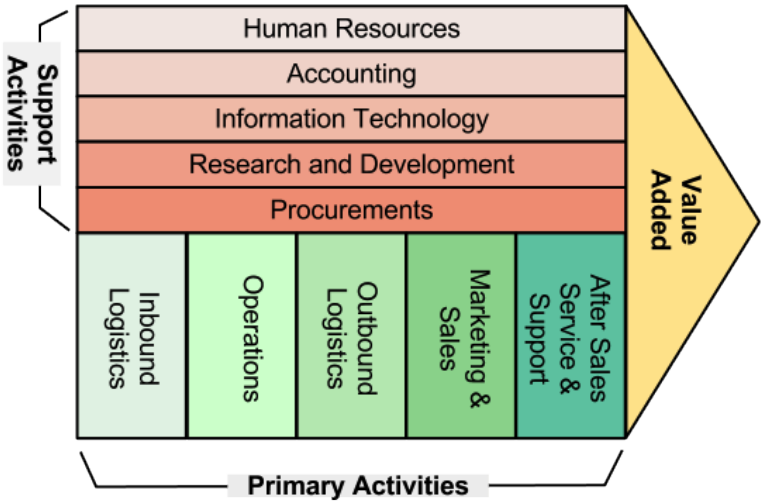

Figure 2.4: Porter's Value Chain

A company's value chain is a system of interdependent activities. This means that the way one activity is performed affects the cost or effectiveness of other activities. For example, if the inputs that the firm purchases from its vendors are not of good quality, this will lead to higher percentage of defects in production, and most likely higher cost for after sales service and support.

A company's cost position relative to its competitors is reflected in the collective cost of performing all its value activities. Similarly, a company's ability to differentiate itself from its competitors is reflected in the contribution of each value activity in satisfying the buyer needs. Ideally, the chain of activities gives the products more added value than the sum of the independent activities' values. Several companies have been leveraging synergies in order to generate new products (Read the SideNote Leveraging Synergies for New Products).

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SideNote: Leveraging Synergies for New Products

... In addition to creating new revenue streams by amping up traditional product and service offerings, organizations have been mining "exhaust data" - information that is a by-product of normal business operations - for use in developing new products. Such by-products, for instance, allow credit-card companies to monetize transactional data from cardholders by analyzing and selling these data to merchants. Similarly, Intuit is beginning to use data amassed from its QuickBooks software to provide new benchmarking and reporting services for small businesses.[a]

[a] 132.

A firm's ability to coordinate its value activities is often a powerful source of competitive advantage. Competitors have a hard time understanding the firm's activities and how they are coordinated across organizational lines.[5] While organizations are usually divided into functional units (e.g., finance, marketing), their success rests on their ability to manage complete processes.

For example, bid preparation, a process that is usually conducted under time pressure, requires cross organizational coordination. The preparation of a bid involves finance, marketing and production departments. Each one of these units may function impeccably independently, however the processes may be impaired due to a lack of coordination among the units. This lack of coordination, a sign of a badly designed process, may slow down processing and lead to late submission of the bid or to an inadequately organized bid, reducing the chances of winning the tender [111].

2.5.2 Resource Based View

The premise of the Resource Based View (RBV) is that firms possess different resources and capabilities. Resources are the physical capital, human capital, and organizational capital owned or controlled by a firm that can be used to conceive of and implement strategies [4]. Capabilities reflect a company's ability to combine resources that the organization can muster in ways that promote superior performance in spite of the opposition stemming from the competition and circumstances [156]. The purpose of capabilities is to improve the productivity of the other resources possessed by the firm [93].

[5] In Resource Based View this is known as **causal ambiguity**.

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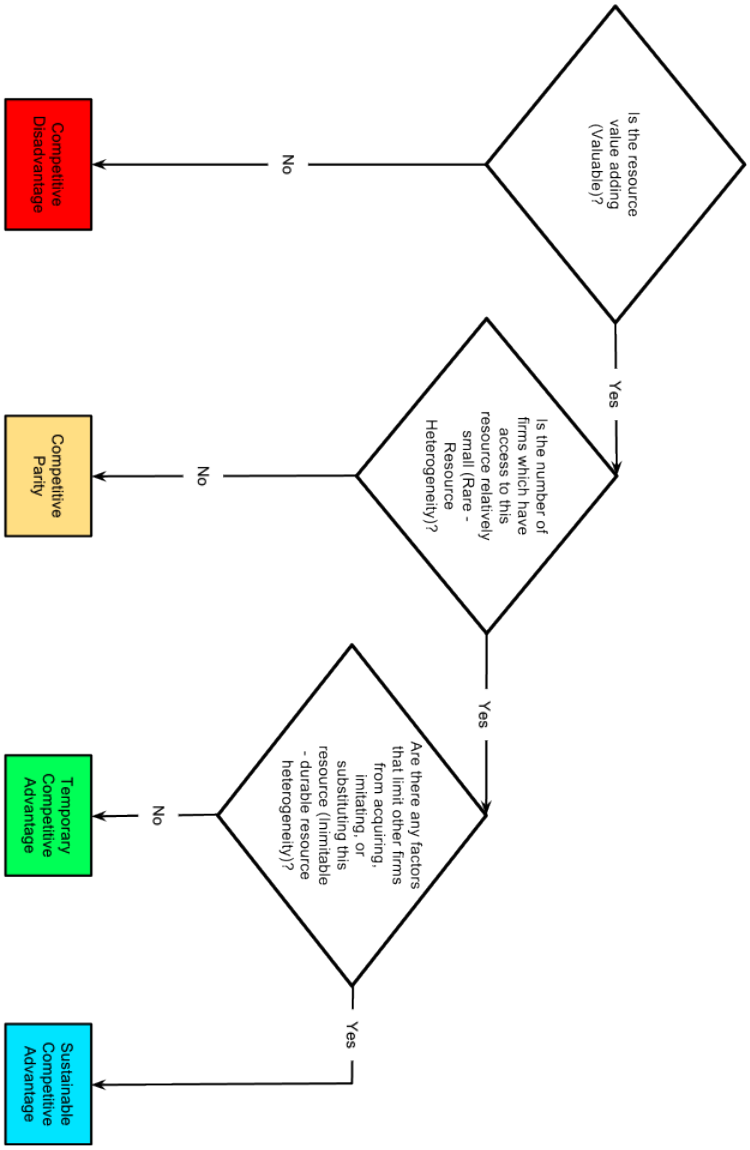

Figure 2.5: Resource Based View

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Some firms leverage their resources and capabilities to implement valuable strategies that their competitors will find costly to implement, and these differences among competing firms can be long lasting. Firms that posses resources and capabilities, which are valuable, rare, and costly to imitate, and they are able to exploit these resources and capabilities in order to develop and implement their strategies will enjoy a sustainable competitive advantage (i.e., generate positive economic profits). If the resources are valuable and rare but not difficult to imitate the firm will enjoy a temporary competitive advantage. If the resources are simply valuable but not rare the firm will achieve a competitive parity. Finally, no firm will want to invest in resources and capabilities which are not valuable, as this will increase the firm's cost but not its revenues thus putting the firm in a competitive disadvantage. The relation between the value and imitability attributes of resources and capabilities and a firm's competitive position is summarized in Figure 2.5.

2.6 Porter's Generic Business Strategies

As we mentioned in the introduction, there are business and corporate strategies. With business strategies firms try to gain a competitive advantage in a specific product market or industry. With corporate strategies firms try to gain a competitive advantage across different industries.[6] Two of the most common business strategies are cost leadership and product differentiation [120]. In reality you will not find any firm that uses only one strategy. But if you look carefully, you may notice that some firms tend to focus on one of these strategies.

2.6.1 Cost Leadership

Cost leadership means that a firm will try to gain a competitive advantage by reducing its cost below that of its competitors. A successful cost leader will enjoy economic profits while the rest of competitors may have zero or negative economic profits. Walmart, SouthWest Airlines, Hyundai, and Charles Schwab are some of the quintessential examples of cost leaders. But even when you look carefully at these firms, you will realize that while cost leadership is their main focus, it is not their only strategy.

[6]Some of the corporate strategies are strategic alliances, corporate diversification, merger and acquisitions, as well as strategies for competing in international markets

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Firms can reduce their cost below that of their competitors due to *economies of scale* or access to technology. A firm can achieve economies of scale taking advantage of any of the following options:

1. Specialized equipment that is only available and feasible with a minimum level of production.
2. Building larger facilities or factories. Walmart has large regional distribution centers serving local stores.
3. Using specialized employees.
4. Spread overhead cost in a higher number of units produced and sold.

Access to new technology, which allows the firm to achieve lower cost per unit, even at lower levels of production, is something that a cost leader can leverage. The new technology may work with manufacturing or service firms. While it is easy to think of the typical manufacturing company, numerous other companies have leveraged technological innovations to reduce their cost and support their cost leadership strategy. For example, Charles Schwab leveraged its IT investments to establish itself as a discount broker. Walmart used its investment in inventory management systems to reduce its cost well below that of its competitors. Cost leaders are likely to fend off the various environmental threats because they can take one or more of the following actions:

1. They can afford to operate at a lower cost in order to deter the threat of new entrants.
2. They can afford to enter into a price war in order to defend against rivals.
3. They can price products competitively in order to avoid the threat of substitute products.
4. They can afford to absorb the higher cost of inputs imposed by suppliers.

If the cost leadership advantage is due to economies of scale this means that the cost leader has more bargaining power against the supplier. For similar reasons the cost leader can leverage its size when negotiating with customers.

2.6.2 Product Differentiation

Product differentiation is the second business strategy that a firm may pursue in its quest to gain a competitive advantage. Product differentiators will try to develop and sell products or services with features that customers find

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valuable. These features can be real (superior design, superior engineering) or perceived (image, prestige associated with the consumption of certain brand name products or services).

Product differentiators will try to increase the perceived value of its product or service relative to competitors' products or services. Firms that want to compete through product differentiation will try to leverage leading edge R&D and/or superior customer service. Successful product differentiation means that the firm can charge a premium on its price, it can sell more of its products at a given price, or achieve higher customer loyalty during an economic downturn [119].

Bang & Olufsen (B&O) is an example of a product differentiator. B&O is a company that produces audio and video products such as speakers, televisions, and telephones. They are best known for their innovative design and product development. They create products of very high quality that are uniquely identifiable as their own creations - ones that appeal to a very specific market of audio and video enthusiasts. This type of brand loyalty is generally unparalleled in the consumer electronics industry except for the likes of Apple. Both of these companies take advantage of their extremely successful brand reputations built up over the years to remain successful product differentiators in their industries.

B&O's product development strategy places high emphasis on differentiating their products in the marketplace in terms of design and quality. The brand reputation that they have built over the years as a result of this strategy has allowed them to charge prices far higher than those of their competitors. Bang & Olufsen appeals to a market willing to pay in order to be associated with the originality of the brand and quality of the products.

Ways to Differentiate According to Porter [120] there are seven ways that firms can use to differentiate their products or services:

1. Changing the properties or features of the product or service (e.g., iPhone).
2. Linkages between functions within the firm provide the firm with a unique advantage.
3. Introducing the product or service in the right time. Not all successful product differentiators are first movers.
4. The physical location of the firms may be another source of product differentiation (e.g., think of your favorite vacation spot).
5. For some firms it is the mix of products or services that they sell. Nike created Nike+, a sensor compatible with an iPod or iPhone and can

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be used with Nike running shoes. Through the sensor a runner can track distance, and running habits, which in turn can be uploaded to a web site. Runners can use this information to customize their training, connect with other runners, and share favourite routes. Through Nike+, Nike has created a community of engaged users (brand loyalty). Nike+ represents a very profitable product for Nike [132].

6. Explicit links between the products or services of a firm with the products or services of another firm.
7. Reputation of a firm and its products or services (e.g., Ferrari, Bulgari, Tiffany's, Armani).

2.6.3 Focused Product Differentiation or Cost Leadership

By focusing on a specific geographic market or a segment of the market firms can create variations of these strategies known as focused cost leadership and focused product differentiation. For example boutique investment banks are small investment banks that specialize in certain industries (e.g., media, technology, healthcare), certain types of transactions (e.g., mergers and acquisitions), or in advisory services for certain geographic regions. Allen & Co. is such a boutique investment bank. In spite of its small size - about 170 employees - the firm is considered the premier investment bank for the media and entertainment sector [91].

In reality, it is not easy to distinguish and classify firms as pure product differentiators or pure cost leaders. The following two reasons, among others, are the source of this difficulty: First, certain industries such as the fashion industry are more focused on product differentiation while others such as agriculture are more focused on cost leadership. Second, research and casual observation shows that firms which are cost leaders do add elements of product differentiation in their strategy and firms that compete on product differentiation do care about their ability to contain costs [106]. One can think of Porter's generic business strategies as the two extremes in terms of strategic choices. Firms compete across the entire spectrum. Nevertheless, it is possible to identify attributes associated with cost leadership or product differentiation. This is the focus of the next section.

2.7 An Analytics Approach to Business Strategy

Product differentiators tend to focus on performance related metrics which are not easy to quantify. For example they may look at product innovation or customer satisfaction. If they are successful in their pursuit to persuade

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customers that their products have unique features they will be able to command higher margins on their sales of products or services.

The decomposition of ROA, known as DuPont analysis or DuPont model, provides managers and investors with a bird's eye view of a firm's financial conditions.Using simple math one can re-write return on total assets (*ROA=Profits/Total Assets*) as a product of profit margin (*Profit Margin = Profits / Sales*) and asset turnover (*Asset Turnover = Sales / Total Assets*).[7]

$$\begin{aligned} ROA &= \frac{\text{Profits}}{Sales} \times \frac{Sales}{\text{Average Total Assets}} \\ &= \text{Profit Margin} \times \text{Asset Turnover} \end{aligned}$$

The DuPont analysis allows analysts to decomposes the firm's financial performance and explore two very important components: The first indicates the firm's ability to generate profits out of each dollar of sales. The second one shows the firm's ability to generate sales out of each dollar of assets.

In general, we expect that product differentiators will enjoy higher gross or operating profit margins. In the context of a DuPont analysis, their ROA is driven relatively more by higher profit margins. Therefore, operating or gross profit margin is a reasonable performance metric for product differentiators.

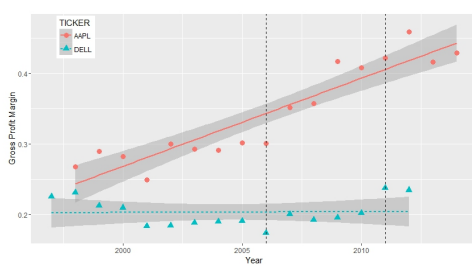

Figure 2.6: GPM: Apple vs Dell

- *Q: Figure 2.6 provides a comparison of the gross profit margin of Apple and Dell. Does the graph support the above position? Explain why.*[8]

On the other hand, cost leaders tend to focus on more quantifiable measures such as cost or time reduction. Cost leaders will try to leverage economies of scale, operational efficiencies (lean operations), and technologies to achieve lowest average cost per unit in their industry. Cost leaders

[7]An alternative approach is to start with return on equity (*ROE=Profits/Equity*) and express it as a product of profit margin, asset turnover, and equity multiplier (*EM=Total Assets/Equity*). How?

[8]The R script used to prepare the analysis/graphs for this section is on p. 67.

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must leverage their assets and extract value out of their assets much better than their competitors.

In general they should be able to leverage their assets to generate more sales. (*How does this relate to economies of scale?*) In the context of a DuPont Analysis, ROA is driven relatively more by asset turnover (efficiency) than profit margins.

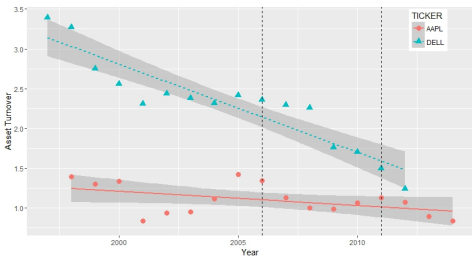

Figure 2.7: ATO: Apple vs Dell

- *Q: Figure 2.7 provides a comparison of the asset turnover of Apple and Dell. Does the graph support the above position? Explain why.*

The combination of profit margin and asset turnover provides ROA. The results of the ROA comparison between Apple and Dell are shown in Figure 2.8. Using the information from all three figures, try to answer the following questions:[9]

- *Does the information in Figures 2.6 - 2.8 support the overall argument that ROA decomposition reflects the firm's business strategy? Explain why.*
- *Period 2006 to 2011 has been marked with dotted vertical lines in all three figures. While the gross margin and asset turnover of Apple and Dell differ in this period, the ROA is more or less the same. What does this mean?*

2.8 Summary and Concluding Remarks

The objective of this chapter was to look at business strategies in order to understand performance related differences across firms. We started by establishing the importance of relative performance (competitive advantage) and drew the distinction in terms of duration of competitive advantage. We looked at several firm performance measures and how they are used. We delved into the discussion on strategy and gained an understanding that

[9]Please see 70 for an answer to these questions.

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Figure 2.8: ROA: Apple vs Dell

performance differences across firms can be attributed to the extent to which their business models encapsulate and reflect their internal (resources and capabilities) and external (industry structure) environment in the formation of their business strategy.

2.9 Practice Questions and Problems

2.9.1 Study Questions

1. Use a simple example in order to explain to someone the idea of opportunity cost.
2. Use Reuters (http://www.reuters.com/finance/stocks) to generate financial performance ratios for BlackBerry. Compare the results to industry averages, and try to explain trends in the light of recent events at BlackBerry.
3. Operating Income to Employees measures operating profits generated per employee. However, results are only meaningful when comparing amongst companies of very similar nature. Why? Provide an example.
4. Video conferencing through Skype is a substitute for air-traveling in order to have a face-to-face meeting with a colleague, customer, or vendor. As such it reduces the demand for air-tickets and the profit

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level in the industry. What other industries might be affected by cheap video-conferencing?

5. What is the difference between primary and support activities?
6. The advantage of controlling for the quality of inputs (procurement) is tied to only one strategy (cost leadership, differentiation, focused cost or differentiation) or all of them? Explain.
7. Relate the following statements to the role of internal and external environment:

   (a) A business model defines how an enterprise interacts with its environment to define a unique strategy, attract resources and develop capabilities to execute it, and, in the process add value for all stakeholders.

   (b) Business strategy involves how companies plan and use their limited resources to gain the most revenues in the future. Successful strategies must define how a company plans to achieve a distinctive and unique position that woos customer from established players and draws new customers into the market.

8. Access to distribution channels is a barrier to entry. How does this barrier relate to the ability of suppliers to forward integrate?
9. Past or expected reaction of incumbents to new entrants can serve as an implicit barrier to entry. New entrants are more likely to be intimidated by an incumbent that has the reputation of aggressive retaliation to new entrants. How can a firm develop such a reputation and what conditions may make a firm to want to sustain such a reputation?
10. In micro-economics you have learned about price elasticity (price sensitivity). Think about the implication of the following two extreme scenarios on bargaining power: A customer who is very price sensitive versus a customer with is completely price insensitive. Do you think that this will affect their bargaining power? How? Support your explanation with an example.
11. What is the NPV of a resource that is not valuable? Explain why.
12. The physical location of the firms may be another source of product differentiation. This may not sound correct today, but location was one of the main reason behind the initial success of Walmart. Why?
13. 'A company's strategy is not static! It is evolving according to changes in its internal and external environment.' Do you agree with this statement? Explain why.
14. The following question was raised by a student in class (Spring 2012): Does it make sense for a firm like Rogers to offer additional services

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to customers such as using business analytics to analyze the buying behavior of customers and notify customers of unusual pattern in their spending if none of its competitors, i.e., Bell or Telus is doing this? For example a cell-phone customer that does not have a data plan starts using it and as a results the monthly bill of this customer goes from around $50/month to $500. Does it make sense for Rogers to try to get in touch with this customer or even offer to reverse some of these charges if none of its competitors offers such a service?

15. Can you try to explain to someone in simple terms the main point of the following quote: *"The behavioral explanation for homogeneity of strategies is more obvious for marketing expenditures. They are easily observable and imitable - competitors' expenditures can be easily duplicated. Marketing expenditures may reach comparable levels among competitors in an industry because of similar conditions which determine product differentiability, buyer characteristics (consumer or industrial products), stage in product life cycle, or close rivalry. Firms use advertising to inform individuals about the quality of their products, or to persuade consumers that their brand is better than those offered by rivals. In such cases, advertising rather than price can become the way in which competitors interact with each other. ... This approach implies that firms in an industry converge towards competitive parity, thus enhancing their chances of survival."*
16. The following question has three parts:
    (a) Will you consider a cell phone company a competitor of a car company, a restaurant company, or a clothes company? Explain why?
    (b) In September of 2012, Troianovski [158] wrote an article in the the Wall Street Journal with the title "Cellphones Are Eating the Family Budget." Read this article and re-visit your answer to the first question.
    (c) How does article relate to Porter's five forces?
17. Can you try to explain to relate the main point of the following quote from Cooney [20] to appropriate theoretical concepts: "*Cloud computing is heavily influenced by the Internet and vendors that have sprung from it. Companies such as Google deliver various services built on a massively parallel architecture that is highly automated, with reliability provided via software techniques, rather than highly reliable hardware. Although cost is a potential benefit for small companies, the biggest benefits of cloud computing are built-in elasticity and scalabil-*

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ity, which reduce barriers and enable these firms to grow quickly. A hybrid cloud service is composed of services that combine either for increased capability beyond what any one of them have (aggregating services, customizing them, or integrating two together), or for additional capacity.''

18. How is the state of the economy or state of the industry (mature or growing) affecting the attractiveness of an industry?
19. What might happen to the boundaries of the credit card industry if people start using more and more their cell phone to make purchases?
20. Revisit the news stories about BlackBerry (pp. 36-37) and try to identify the company's new business strategy.

2.9.2 Multiple Choice Questions

1. Fixed cost and rivalry among existing competitors.

   (a) If fixed costs are high it is more likely that competitors faced with losses will engage in price wars (lower prices). This means that the rivalry among existing competitors is less intense.
   (b) If fixed costs are high it is less likely that competitors faced with losses will engage in price wars (lower prices). This means that the rivalry among existing competitors is more intense.
   (c) If fixed costs are high it is less likely that competitors faced with losses will engage in price wars (lower prices). This means that the rivalry among existing competitors is less intense.
   (d) If fixed costs are high it is more likely that competitors faced with losses will engage in price wars (lower prices). This means that the rivalry among existing competitors is more intense.

2. Threat of new entry depends on barriers to entry and reaction from existing competitors.

   (a) If the threat of retaliation is low, barriers to entry are low, and threat of new entry is low.
   (b) If the threat of retaliation is low, barriers to entry are high, and threat of new entry is high.
   (c) If the threat of retaliation is high, barriers to entry are high, and threat of new entry is low.
   (d) If the threat of retaliation is high, barriers to entry are high, and threat of new entry is high.

3. Porters five forces or industry structure view is a framework for align-

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ing an organization with its external environment and a way to evaluate the relative attractiveness of ...

(a) All provided choices are correct.
(b) An industry or market.
(c) A customer or a segment of customers.
(d) An IT investment related to an opportunity to gain a competitive advantage.
(e) A supplier or the network of suppliers.

4. Companies like Toyota, GM, Ford and Honda have introduced hybrid cars, which are relatively better for the environment. This is an example of evolving strategy that aligns a company with its external environment. From a business strategy standpoint, a hybrid car like Toyota Prius or Ford Escape is an example of

(a) cost leadership
(b) product differentiation
(c) focused product differentiation
(d) focused cost leadership

5. A magazine article reported that "... traditional grocers like Sobeys, who are increasingly losing market share to new entrants such as Walmart and big box retailers such as Costco, as well as dollar stores and corner groceries ... have to play to their strengths, such as knowledge of the local market and customer insight, things that have been overlooked in the recent drive toward operational efficiency. ... Grocers will increasingly have to tailor their stock to the local market and develop multi-channel supply chains. And if they're going to be successful at that ... technology will play a key role." According to the quote, groceries like Sobeys should compete through ...

(a) focused product differentiation.
(b) focused cost leadership.
(c) cost leadership.
(d) product differentiation.

6. What is a competitive advantage?

(a) A product or service that an organization's customers value more than similar offerings from a supplier
(b) A product or service that an organization's customers value less than similar offerings from a supplier
(c) A product or service that an organization's customers value less than similar offerings from a competitor

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(d) A product or service that an organization's customers value more than similar offerings from a competitor.

7. In a magazine article it was reported that "... Walmart said it would buy VUDU, which sells and rents downloadable movies and TV shows that can be viewed on such Web-connected devices as Blum-ray disc players and some LG televisions. ...Buying VUDU pushes Walmart further into the online territory dominated by Apple, Amazon.com, and Netflix, and helps the retailer compensate for weakness in demand for CDs and DVDs sold through brick-and-mortar outlets." Based on the story, it seems that the company's current approach to evolve its strategy is a response to ...

   (a) change in supplier capability (supplied products).
   (b) technological innovation.
   (c) change in consumer preferences.
   (d) change in consumer preference, technology, and supplier capability.

8. If buyer propensity to substitute is ...

   (a) high the threat of substitute products is high.
   (b) there is not enough information to evaluate this.
   (c) low the threat of substitute products is high.
   (d) high the threat of substitute products is low

.

9. In a magazine article about Mobilicity, Canada's newest cellphone company it was reported that [... Mobilicity is about to ... reveal plans ... of the company's offensive ... an aggressively priced unlimited talk, text, long-distance and data package for $65. ...Offering unlimited data plans has its perils, though, since it can eat into the bottom line. Mobilicity is hoping to keep its cost structure low enough that it can offer the discount rates. ... The Mobilicity offering will likely appeal to a segment of the incumbent wireless providers' customer base ... For the corporate road warrior, or the entertainment road warrior, or a guy who travels a lot or has lots of friends in American universities, this is a great plan ...]. Which generic business strategy seems to be described in this quote?

   (a) Focused product differentiation
   (b) product differentiation
   (c) Focused cost leadership
   (d) cost leadership

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2.10 Business Analytics Practice Problems

2.10.1 Market Valuation of Apple and BlackBerry

Tobin's *q* is defined as the market value to replacement cost (book value) of its assets. In its simplest form it is written as follows:

$$\textit{Tobin's } q = \frac{\textit{Firm Market Value}}{\textit{Book Value of Total Assets}} \tag{2.1}$$

If the market value is greater than the value of the company's book value of assets, Tobin's q is greater than 1.0. This means that the market values the firm's assets more than their book value and it reflects investors' perception regarding the firm's potential. Appendix B (page 306) provides information on how to calculate Tobin's q with Compustat data.

The objective of this exercise is to leverage Tobin's q in order to visualize how investors see the value of Apple and Blackberry over time. You can do this by estimating Tobin's q for Apple over the period 2001 to 2016. For the rest of this exercise you use

1. Extract Compustat data needed to calculate the market to book value approximation of Tobin's q for Apple and Blackberry over the period 2001 to 2016.[10]
2. Estimate the Tobin's q for Apple over the period 2001 to 2016.
3. Generate a graph showing Tobin's q for Apple.
4. Estimate the Tobin's q for BlackBerry over the period 2001 to 2016.
5. Generate a graph showing Tobin's q for BlackBerry.
6. Leverage your knowledge about these two companies to interpret these graphs and summarize your key findings in a short paragraph.

2.10.2 Contrast Business Strategies

In 2.7 (p. 56), we have seen how to use DuPont analysis to contrast Apple versus Dell. The script and instructions on the comparison of Apple versus Dell was done are on p. 67. Find two publicly traded firms and contrast their strategies using DuPont analysis. You will need one firm for which you can find some evidence (e.g., based on news stories) that competes as product differentiator, and another one that competes based on cost leadership. Both firms have to be in the same industry.

[10] See Appendix A on how to extract data from Compustat.

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2.10.3 Wireless Market: US versus Canada

Canadian consumers feel that their side of the wireless market is less competitive and less consumer friendly [99]. An attempt by Verizon to enter the Canadian market was met by strong resistance by the big three Canadian firms, Rogers, Bell, and Telus [157, 99, 30]. The objective of this exercise is to compare the barriers to entry and rivalry among existing competitors between US and Canada.[11]

1. Appendix C.1, (p. 309) provides information on how to generate accounting proxies for barriers to entry with Compustat data.
2. Appendix C.2, (p. 310) provides information on how to generate accounting proxies for rivalry among existing competitors with Compustat data.
3. When you extract data from Compustat make sure to include the variable location of the firm's headquarter.
4. Generate proxies for both sides of the market (generate proxies by location).
5. Generate appropriate summary statistics and graphs to compare the two markets.
6. Tell your story. Is there a difference in industry structure and what is its effect on profitability?

[11] The solution of this problem is in Appendix D (p. 315).

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2.11 Solutions to Selected Practice Problems

2.11.1 ROA Decomposition and Business Strategy

The objective of this tutorial is to replicate the R script used to generate the annalysis used to perform the ROA decomposition of Apple and Dell (Section 2.7, p. 56). We start by setting the working directory to the file that contains our dataset, create the new data frame in R, use the `str` to review the structure of our data.

```
> setwd("... StrategicAnalytcs")
> AppleDell <- read.csv("AppleDell.csv")
> str(AppleDell)
```

```
'data.frame':        35 obs. of  12 variables:
$ GVKEY            : int  1690 1690 1690 1690 1690 1690  ...
$ Data.Date        : int  19970930 19980930 19990930  ...
$ FY               : int  1997 1998 1999 2000 2001 2002  ...
$ TICKER           : Factor w/ 2 levels "AAPL","DELL": 1 ...
$ GIC.Groups       : int  4520 4520 4520 4520 4520 4520  ...
$ Assets           : int  4233 4289 5161 6803 6021  ...
$ GP               : num  1486 1590 1781 2250 1337 ...
$ Sales            : int  7081 5941 6134 7983 5363 5742  ...
$ AvTA             : num  NA 4261 4725 5982 6412 ...
$ AssetTurnover    : num  NA 1.394 1.298 1.335 0.836 ...
$ GrossProfitMargin: num  NA 0.268 0.29 0.282 0.249 ...
$ ROA_GP           : num  NA 0.373 0.377 0.376 0.209 ...
```

We use the `ggplot` generate the graph that lets us contrasts ROA of Apple versus Dell. Notice that we are using the gross profit margin based specification of ROA (`ROA_GP`) and our horizontal axis is the fiscal year (`FY`). Since we want to capture both firms in one graph and `TICKER` is the variable that indicates each firm, we use it to pass the appropriate argument within the `geom_point (aes (linetype=TICKER, shape=TICKER, color=TICKER)`. In other words, we specify that there should be a different line, shape, and color to reflect each one of the companies in the sample. The last line lets us control the intervals (years) shown on the horizontal axis. We use the function `scale_x_continuous` to indicate that we want breaks in the sequential range (`seq()`) from `min(fiscal year)` to `max(fiscal year)` at two year increments (`by=2`).

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```
> library(ggplot2)
> ROA_g <- ggplot(AppleDell, aes(x=FY, y=ROA_GP)) +
+  geom_point(aes(linetype = TICKER, shape=TICKER,
color=TICKER), size=3) +
+ xlab("Year") + ylab("ROA")+
+ scale_x_continuous(breaks = seq(min(AppleDell$FY),
max(AppleDell$FY), by = 2))
```

Given that our objective is to contrast the two companies, we are going to add a trend line and indicate the area where the ROA of the two firms is comparable. We start by adding the trend line in our graph using the `geom_smooth(method = "lm" ....` Notice that we use the `TICKER` to distinguish between the two firms.

```
>  ROA_g <- ROA_g +
+ geom_smooth(method = "lm", aes(linetype = TICKER,
color=TICKER), size=1)
```

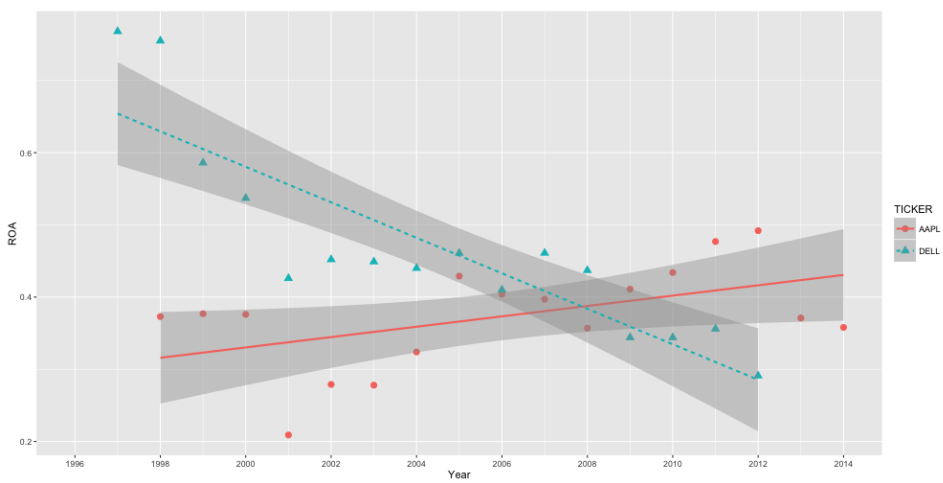

Figure 2.9: ROA: Apple vs Dell

To strengthen our message, we are going to add a trend line, as well as vertical lines to show the years (2006 and 2011) when the ROA of the two companies are close to each other. We selected the years, after the visual inspection of our graph (Figure 2.9). We add the vertical line to show

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the years when the two ROAs are close to each other using the function `geom_vline` and specifying the vertical intercept (x-intercept) as follows: `xintercept=c(2006,2011)`.

```
> ROA_g <- ROA_g +
geom_vline(xintercept=c(2006,2011), linetype="dashed") +
+ theme(legend.position=c(.9, .9))
>  ROA_g
```

The following script will let us contrasts Gross Profit Margin of Apple versus Dell. The output is the one shown in Figure 2.6 (57).

```
> GPM_g <- ggplot(AppleDell, aes(x=FY, y=GrossProfitMargin)) +
+ geom_smooth(method = "lm", aes(linetype = TICKER,
color=TICKER), size=1) +
+ geom_point(aes(linetype = TICKER, shape=TICKER,
color=TICKER), size=3) +
+ xlab("Year") + ylab("Gross Profit Margin")+
+ geom_vline(xintercept=c(2006,2011), linetype="dashed") +
+ theme(legend.position=c(.1, .9))
>  GPM_g
```

With minor adjustments, we create the final graph that contrasts Asset Turnover of Apple versus Dell. The output is similar to the one shown in Figure 2.7 (p. 58).

```
> ATO_g <- ggplot(AppleDell, aes(x=FY, y=AssetTurnover)) +
+ geom_smooth(method = "lm", aes(linetype = TICKER,
color=TICKER), size=1) +
+ geom_point(aes(linetype = TICKER, shape=TICKER,
color=TICKER), size=3) +
+ xlab("Year") + ylab("Asset Turnover")+
+ geom_vline(xintercept=c(2006,2011), linetype="dashed") +
+ theme(legend.position=c(.9, .9))
>  ATO_g
```

Practice problems: How would you modify the above script in order to compare three companies?

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Answer to Apple vs Dell questions: Apple was chosen as an example of a product differentiator and Dell as a cost leader. Using figures 2.6 - 2.8 to visualize the ROA decomposition we can observe some key differences in how two different strategies can affect some aspects of financial performance.

Figure 2.6 - gross profit margin comparison: As expected, Apple as the product differentiator yields a significantly higher profit margin than Dell. This is because Apple's strategy enables it to leverage its brand reputation to charge noticeably higher prices than any of its competitors, thus achieving a higher margin on its products.

Figure 2.7 - asset turnover comparison: In this scenario it is clear who the cost leader is. Dell has a higher turnover each year because a quicker turnover is a result of higher asset efficiency - a direct impact of cost leadership.

Figure 2.8 - ROA comparison: This figure shows that it is possible for two competitors in the same industry to achieve relatively similar ROAs even though they have different strategies. In this figures this happened in the period between 2006 to 2011. In other words, firms can be equally successful either through a product differentiation or cost leadership strategy.

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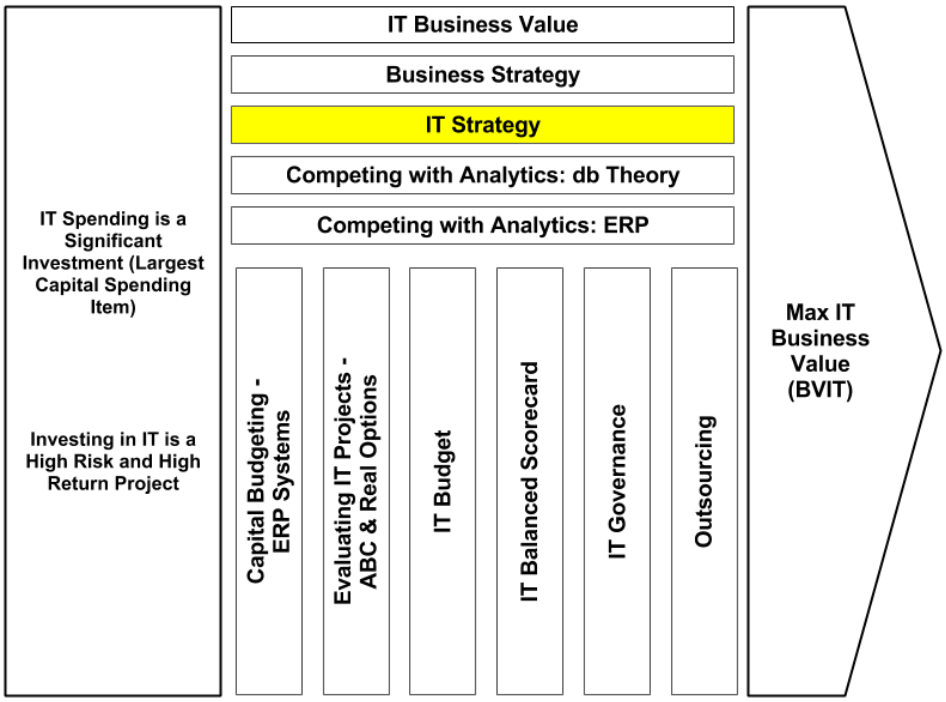
Chapter 3

IT Strategy



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Learning Objectives

By the end of this chapter, students should be able to describe, interpret, and apply the following concepts:

- Managerial perceptions regarding role of IT in firms
- Factors driving IT related decisions
- Perceived role of IT on the firm's competitive environment
- IT strategy
- McFarlan's strategic grid
- Use of McFarlan's strategic grid & strategic alignment
- IT capabilities
- Payoffs from IT capabilities and IT spending

3.1 Introduction

While figures vary over time and across industries, the fact is that for most firms, IT investments constitute their largest capital-spending item. Nevertheless, Stratopoulos and Lim [152] report that industry-wide managerial attitudes regarding the value of investing in new IT (IT innovation) have fluctuated over the years. Periods of optimism are followed by periods of pessimism.

During periods of optimism expectations of senior executives and board members tend to become unrealistic. IT innovation is celebrated as a panacea for all business ills. During periods of pessimism doubt prevails about the value of investing in new IT. Executives and board members tend to discount heavily the expected benefits from IT investments. A typical argument that persists during periods of pessimism is that IT investments are easily replicated, therefore they are not a source of competitive advantage.

IT strategy is the shared view, among a firm's top management team (TMT),[1] regarding the role of IT in the organization. In very general terms, a firm's IT orientation can be operational or strategic. The role of IT may be to support or lead the firm's strategy; it may be a necessary evil or leading edge. The firm may be an IT conservative or IT innovative. A TMT's attitude toward IT might be influenced by senior executives' prior functional experience, education, or personal preference. However, it should reflect industry requirements and the role that IT can play in affecting the firm's competitive position.

[1] Typically, a firm's TMT includes the company's Chief Executive Officer (CEO), Chief Financial Officer (CFO), and Chief Operating Officer (COO).

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In the rest of this chapter, we will start by reviewing some of the factors driving IT strategy (section 3.2), and explore some of the most commonly encountered views regarding the role of IT (3.3). This will be used as a foundation for understanding McFarlan's strategic grid in section 3.4. When it comes to IT strategy, McFarlan's strategic grid is the equivalent of Porter's generic business strategies. It provides a typology of IT strategies. We will close the chapter with a discussion about the importance of aligning IT and business strategy (3.5) and revisit the payoffs from IT investments (3.6).

3.2 Factors Driving IT Strategy

IT strategy has been described as the shared vision among the firm's TMT. Senior executives decide whether IT represents a strategic resource by answering to the following questions:[2]

1. Can IT change the basis of competition?
2. Can IT build barriers to entry?
3. Can IT change the balance of power in supplier relationships?
4. Can IT generate new products?

3.2.1 IT and Basis of competition

As we have seen in Chapter 2, firms develop their business strategy to differentiate themselves from their competitors. IT has the potential to allow some firms, which were competing in an industry where competition was based on cost leadership, to change certain features of the product/service that they were offering. By adding value to their products/services they can change the basis of competition from cost leadership to product differentiation. On the other hand, firms may use IT to change the basis of competition from product differentiation to cost leadership. Firms can use IT to reduce existing staff or grow without hiring staff, improved material use, increased machine efficiency through better scheduling or more cost-effective maintenance, and lower inventories.

Assuming that the features and functionality of the product/service has remained the same, a firm that can leverage IT to achieve a substantial reduction in its cost per unit can shift the basis of competition from product differentiation to cost leadership. The following quote from McFarlan [102] provides an example of how a firm leveraged IT to switch its strategic focus from cost-leadership to product differentiation.

[2]The discussion in this section is based on McFarlan [102].

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... in the mid-1970s, a major distributor of magazines to newsstands and stores was in an industry segment dominated by cost-based competition. For years it had used electronic technology to drive costs down by developing cheaper methods of sorting and distributing magazines. While using less staff and lower inventory, it had achieved the position of low cost producer.

In 1977, however, the distributor decided to build on the fact that its customers were small, unsophisticated, and unaware of their profit structures. By using its records of weekly shipments and returns from a news stand, the distributor could identify what was selling on the news stand. It developed programs that calculated profit per square foot for every magazine and compared these data with information from news stands in economically and ethnically similar neighborhoods that often carried very different mixes of merchandise. The distributor could thus tell each news stand every month how it could improve the product mix. Instead of just distributing magazines, the company has used technology to add a valuable inventory management feature that has permitted it to raise prices substantially and has changed the basis of competition from cost to product differentiation.[102]

The story is teaching us a very important lesson. While now all firms seem to have discovered the power of big data and business analytics, use of such tools by IT innovative firms has been around for many years. The major distributor in the story leveraged information that the firm had collected to identify patterns in the sales of news stands (business intelligence), and used this knowledge to add value to the product the firm was selling. The firm, in this circa 1970s story, used business analytics to change the basis of competition from cost leadership to product differentiation.

Google Drive (Figure 3.1) provides a more recent example of how IT can be used to change the basis of competition. Google Drive provides data storage (up to 15 GB) and web based document editing software. The software pales in comparison to MS Office, however Google has managed to attract millions of price sensitive users away from MS Office. Google Drive is free. Google has shifted the basis of competition in the market for editing software. As the following excerpt from the Wall Street Journal [36] indicates, this approach has been successful. Google has become a formidable opponent for Microsoft.

Figure 3.1: Google Drive

... Google Inc. has signed a deal to provide email and on-line-collaboration software to more than 100,000 employees at General Motors Corp., according to people familiar with the matter. .... the deal could be a watershed

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moment in Google's quest to challenge Microsoft Corp.'s dominance in application software, marking the largest deal since the Internet company began selling what it calls Google Apps in 2007. ... The deployment of Google Apps at GM would be a "feather in Google's cap" and a "credibility boost for cloud services for large companies," ...

The article concludes by summarizing Microsoft response as follows: *To counter Google Apps, Microsoft earlier this year introduced Office 365, which includes the latest versions of Microsoft Office that can be accessed from a Web browser ... The full Office 365 package starts at $24 per user per month....*

Food for Thought Do your own research and find out about other initiatives (e.g., office on line and partnership with Dropbox) that Microsoft has taken to respond to this threat. What is your assessment? Has Microsoft being successful in neutralizing this threat? Explain Why.

3.2.2 IT and Barriers to Entry

In Chapter 2, we have seen that the threat of new entry places a downward pressure on the potential profit of an industry. Therefore, senior executives must evaluate the effect that IT can have on barriers to entry. The effect of IT on barriers to entry is not always the same. In some cases, it creates a new one or raises an existing barrier to entry, while in some other cases it reduces or eliminates an existing barrier.

1. Economies of scale: Porter [122] provides the following historical example of how large firms have used their size to take advantage of new IT. ... *Strategic decisions of leading competitors often have a major impact on the threat of entry. Starting in the 1970s for example, retailers such as Walmart, Kmart, and Toys "R" Us began to adopt new procurement, distribution, and inventory control technologies with large fixed costs, including automated distribution centers, bar coding, and point of sale terminals. These investments increased the economies of scale and made it more difficult for small retailers to enter the business (and for existing small players to survive).*

Food for Thought

1. Is this argument still valid? Can you identify recent technological innovations that may have neutralized this barrier?

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2. What happened to KMart, WalMart and Toys "R" Us? What was the effect of e-commerce (Internet and Amazon in particular) on these companies. Think about the business model behind e-commerce.

2. Network effects: A buyer's willingness to buy a firm's product or service increases with the number of buyers who buy the firm's product or use its services. Companies have been using IT in order to generate network related effects. In some cases, this is directly related to the firm's product or service. For example, the appeal of Facebook, Instagram, Twitter and Skype increases as more and more users join their network. In numerous other cases, firms may use technology to enhance the functionality and appeal of their products. For example, consider Nike's effort to create a community of engaged users (brand loyalty) with its Nike+ (see p. 56).

Side Note: CUNA Mutual Brings Loans to Phones

According to Murray [110] ... *CUNA Mutual Group provides services such as insurance and asset management to ... credit unions. One core service is Loan liner, a software-as-a-service application that manages the documentation and compliance processes for loan applications. CUNA Mutual saw the potential for mobile devices to help credit unions make more loans and attract younger members.*

... Since launching the smart phone loan app, ... it has processed about 35,000 loan applications from it, generating more than $335 million in loan application volume. The smart phone app also has a high completion rate–more than 50%, or about twice the typical rate for other types of loan applications.

3. Customer switching cost refers to the fixed costs that buyers face if they decide to switch to another product or service. Switching cost may take multiple forms. It can be physical capital, such as investment in customized hardware. It can be human capital, such as training time and effort needed to learn a new software (Read the Side Note: CUNA Mutual Brings Loans to Phones). Finally, in some cases it may be simply based on human traits such as inertia or risk avoidance (status quo). If customers are bound by any form of switching cost, they are more likely to stay with the existing supplier.

Similarly, firms that have connected their logistics facilities to a supplier's manufacturing facilities through a customized supply management system

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are facing a switching cost. In the ideal case, IT has to be simple to use but it must also contain some complex and useful procedures that are unique to the customer's processes.

The higher the switching cost - actual or perceived - the harder it will be for new entrants to enter the market and find new customers.

4. Capital requirements refer to the need to invest large amounts of resources in order to compete in an industry. The quote from Porter [122] on page 75, provides an example of how the capital requirement associated with IT investments had become a barrier to entry for smaller companies. On the other hand, management statements like the following one, show that firms can leverage IT innovations such as cloud computing to alleviate the burden of capital requirements:

" *... I got interested initially in cloud because of the pricing model: the fact that I could potentially buy capacity as I needed it and pay for it as Op Ex instead of Cap Ex, ... That essentially lowers the bar for innovation because I can build something quickly and deploy it quickly. This is a hugely important phenomenon in cloud.*" [117]

5. Incumbent advantage? Existing firms may have a cost or quality advantage. Encyclopedia Britannica was the oldest and most prestigious English language encyclopedia The first issue was published in 1768. However, in 2012 the company succumbed to the ongoing pressure from on-line information sources - most notably Wikipedia - and officially announced the end of its print edition. In the case of Encyclopedia Britannica the incumbent advantage was eroded by the power of crowd sourcing, which was made possible through the Internet.

6. Access to distribution channels works as a barrier to entry for newcomers because they have to secure distribution of their product or service. Traditional commerce rests on the need for a physical market as a distribution channel through which producers will get in touch with customers and sell their products. However, the introduction of e-commerce has made the need for a physical market obsolete. In some markets such as books, music, and movies the web is a much more convenient outlet than brick-and-mortar stores. Think about the effect of Internet on iconic names such as Blockbuster, Borders, and Tower Records.

Amazon hopes to use drones for deliveries in the future. According to Jeff Bezos [8], "*... tiny drones will one day be whizzing overhead and dropping*

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Amazon packages at America's doorsteps." Amazon has filed several patents related to drone delivery. One of them proposes flying warehouses (see Figure 3.2).[3]

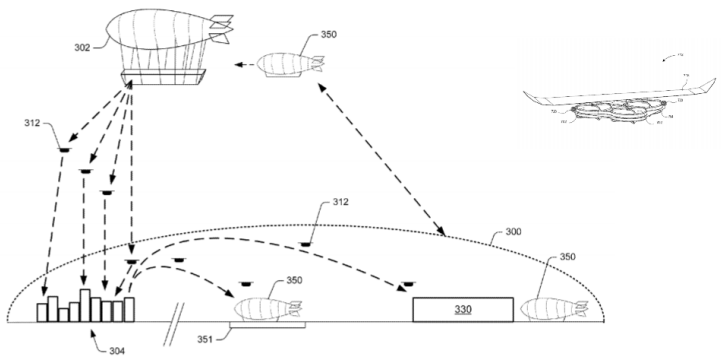

Figure 3.2: Amazon Patents for Airborne Warehouse

Food for Thought Read question 10 (p. 100).

7. Government policy may limit entry into the industry via various bureaucratic constraints or controls and regulations. Though you may not see a direct connection between government policy and industry barriers, there are numerous examples on how government policy on IT affects firms. For example, think of the effect of privacy restrictions on firms that work on the development or use of electronic health records. Think about the effect of similar restrictions on what kind of information Facebook can mine.

Food for Thought In a special issue on AI, The Economist [33] had the following statement: "*Barriers to entry from owning and generating data could lead to a handful of dominant firms in every industry.*" Find/read the article and explain what this means?

3.2.3 IT and Balance of Power

Firms have been using IT in order to alter the balance of power between buyers and sellers. In the following paragraphs we are going to focus on two

[3]Read the article about Amazon's new patents on drone based delivery https://www.cbinsights.com/research/amazon-warehouse-patent/

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examples. First, during the mid-nineties Walmart participated in a joint project, known as Collaborative Planning Forecasting Replenishing (CPFR), with Warner-Lambert (the maker of Listerine) that aimed to coordinate the supplier's and retailer's forecast of demand for Listerine [160]. In subsequent years numerous firms implemented similar inter-organizational initiatives and have achieved drastic reductions in inventory (18-46%), increase forecasting accuracy (18-25%), increase sales revenues (10-15%), reduced safety stock (11-45%), and increased productivity (30-45%) [142]. This example, showcases how Walmart leveraged the new technology in order to form closer ties with its suppliers.

The second one describes how John Deere has leveraged IT in order to improve the experience of its customers and increase (one could argue impose) customer loyalty. Murphy [108] describes how John Deere used telematics to get closer to its customers as follows:

" *... Think of a green John Deere combine harvesting wheat in a remote corner of Kansas, or a tractor in a cornfield in Argentina. The nearest technician might be hours away, so any breakdown can cost precious work time. Now picture a Deere dealer calling to tell the farmer that it looks like the air filter is wearing out, so could he come out to replace it soon before it causes a problem.*

On more than 40,000 newer Deere vehicles, in 43 countries, a dealer now can do that kind of remote preventive monitoring and also diagnose trouble codes when they appear. Launched in 2011, the Service Advisor Remote software can capture machine readings, clear codes if there is a false alarm, and even wirelessly download a fix to the vehicle if there's a software-related problem.

Deere & Co. has offered that kind of electronic diagnostics for 13 years, with its PC based Service Advisor software. But that setup required a technician to visit the machine and connect the PC to it. As the coverage and bandwidth from cellular networks improved, and costs dropped, Deere decided it could add remote diagnostics, using a cellular service - with a satellite service option in some countries - that it calls JDLink.

The story of John Deere indicates how firms can leverage IT to alter the balance of power between buyers and sellers. In the case of John Deere the aim is to increase the brand loyalty of customers.

Food for Thought

1. What will happen if the owner of the John Deere chooses to use generic parts to do the repair?

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2. What emerging technology is John Deere leveraging in this story?

3.2.4 IT and New Products

Countless new products have been available because of IT or with IT; however, one of the most notable contributions of IT is in terms of the ability to achieve *mass customization*. The term, which sounds like an oxymoron, means that firms can customize products to the needs or preferences of individual users and achieve this in a massive scale.

Perhaps, one of the best examples is that of Land's End [78, 68]. In October of 2001, Land's End (now part of Sears) announced its custom tailored chinos program. A web-enabled system that allowed customers, for a premium of about $20, to customize their pants.

Customers could go to the firm's web site and instead of ordering one of the pre-maid pair of chinos, specify length, waist size, color, and style options such as cuffs or pleats. The program was extremely successful. Approximately a year after the launch of the new service, 40% of all jeans and chino's sold on the Land's End web site were custom made. Companies like MakeYourOwnJeans have taken this idea to a new level (see Figure 3.3). The web driven company lets you customize your jeans, your suits, dress shirts, and jackets.

Figure 3.3: MakeYourOwnJeans

3.2.5 IT and Hyper-competition

Technological innovations have the potential to change the competitive landscape. The introduction of the Internet was a paradigm shift in terms of the

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way senior executives think about sustainable competitive advantage. The combination of cloud computing with IoT, Blockchain (smart contracts), and AI have the potential to reshape the competitive landscape in many industries.

In the past, firms could develop and sustain their competitive advantage for extensive periods. However, in more recent years, it has become more and more difficult for firms to sustain their competitive advantage. **Hyper-competition** is a term that was introduced by Prof. D'Aveni to capture this new competitive environment [25]. According to D'Aveni, 'rapid technological changes' is one of the four forces that fuel hyper-competition. The other three are: 1) Customer changes and fragmenting of customers preferences. 2) Falling geographic and industry boundaries. 3) Deep pockets among competitors due to the rise of giant global alliances.

3.3 General Views Regarding Role of IT

Given that IT strategy has been defined as the shared view, among a firm's senior executives regarding the role of IT in the organization; in this section, we are going to explore some of the most common views that senior executives have adopted regarding the role of IT in their firm. These views can be classified either in terms of the functional role of IT or in terms of the firm's position towards IT.

From a functional standpoint the role that IT can play is to automate existing processes, as a channel for information flow within the firm, or as force that can transform an industry. From the firm's standpoint, the position that a firm may adopt towards IT is that of a leader or follower, innovative or conservative, offensive or defensive IT adopter.

3.3.1 Functional Roles of IT

Automation is one of oldest, and perhaps the most common, functional role that IT can play in a firm, i.e., IT is replacing human labor in automating business processes. Typically, senior executives who adopt this view tend to focus on replacing 'expensive and unreliable human labor' with IT. This means that from a payoffs standpoint, the primary goal is that of cost reduction and secondarily on improving quality. Senior executives who adopt the automation view tend to see IT as an overhead costs that has be

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carefully managed.[4]

IT is a source of new information or as a channel that facilitates the flow of information within the company. Depending on the direction of the flow, the functional role of IT may be to provide information to senior management or front line managers and employees. Zuboff [172] introduced the portmanteau terms **informate up** for the former and **informate down** for the latter.

Informate Up means that IT provides information to higher levels of the organization making it easier and more efficient for senior executives to exercise their organizational control and coordinate activities across the value chain. Senior executives see IT as a means of facilitating their access to information about every aspect of their firms' operations. The justification for this investment is that it provides timely information that enables them identify problems and take appropriate actions immediately. The following excerpt from Henschen [60] describes such an investment and its expected benefits.

... P&G's projects related to analytics and data visualization are changing how the consumer goods company operates and the day-to-day conversations its executives have about performance. ... At its core is a series of analytic models designed to reveal what's happening in the business now, why it's happening, and what actions P&G can take. The "what" models focus on data such as shipments, sales, and market share. The "why" models highlight sales data down to the country, territory, product line, and store levels, as well as drivers such as advertising and consumer consumption, factoring in region- and country-specific economic data. The "actions" analyses look at levers P&G can pull, such as pricing, advertising, and product mix, and provide estimates on what they deliver.

Informate Down means that IT is used to direct information from top to bottom. Senior executives focusing on such systems aim to provide critical and timely information to front line managers and employees. Software like the Loan liner (see Side Note: CUNA Mutual Brings Loans to Phones on p. 76) empowers cars salespeople to close a deal and make arrangements for a car loan right at the time when the potential customer has just test driven the car.

[4]The discussion on functional roles of IT is based on the pioneering work of Zuboff [172] and Schein [135].

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Senior executives that see IT is an agent of empowerment and autonomy are more likely to develop a view that treats IT as an agent of some amount of organizational transformation. Typically these kind of investments require changes to organizational architectures of structures, processes, and reward systems. This leads to our final function role that IT can play in a firm, i.e., transform.

Transform means that senior executives view IT is a vehicle for fundamentally altering the structure and competitive forces of the industry where the firm operates. IT is the means for changing the firm's relationships with its suppliers and customers, and altering the products, markets, organizational structures and organizational boundaries, inter-organizational relationships, and even the management processes themselves. The story of the distribution firm quoted on p. 73, is an example of using IT to transform a firm's relationship with its customers.

3.3.2 Firm's Disposition Towards IT

Approaching general views held by senior executives regarding the role of IT in the firm, from a disposition standpoint, we have the following classifications: leader or follower, innovative or conservative, offensive or defensive IT adopter. Notice that there is a major overlap when trying to define innovators, leaders, and firm's adopting an offensive approach. Similarly the distinction between IT conservative or IT follower or defensive IT firms is not always clear.

Innovative versus Conservative When it comes to the perceived role of IT within the firm, the key differences between firms that adopt an innovative position versus firms that adopt a conservative position can be summarized in terms of their objectives and their approach to IT investments. IT innovators want to be IT leaders within their industry. Typically they are the first in their industry to explore, develop, and capitalize on innovative IT initiatives. While they may not be the first to introduce or adopt every single new technology, IT innovators have a consistent IT strategic perspective. Firms such as Walmart , P&G, FedEx, UPS, and Harrah's Entertainment have all been noted as IS leaders in their respective industries.

IT conservative firms tend to adopt a more cautious approach with IT investments, and they do not wish to establish themselves as IT leaders in their industry. It is very unlikely that they will be the first in their industry to invest in a new technology. IT conservative firms will invest in IT only

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after it has been tested and proven successful by major competitors. In other words they will not invest in high risk IT projects.

In general and as we have seen in Chapter 1 (p. 15), IT innovators are more likely to have both greater levels of success (higher payoffs) as well as more pronounced failures (higher risk) than IT conservatives.

Offensive versus Defensive approach to IT The distinction between firms with offensive versus defensive view of IT rests on the firm's IT related priorities. Firms that rely on technology to deliver efficient, secure, and uninterrupted services tend to favor IT investments on mature and well tested systems. These firms tend to adopt a defensive approach to IT. Firms with a defensive approach to IT tend to indicate a preference for investments that ensure continuity of firm's operations, rather then a preference to leverage IT to improve the firm's competitive position.

On the other hand, firms with an offensive disposition to IT, tend to rate preference for reliable IT operations at the same level as their preference to pursue IT initiatives that can improve the firm's competitive position. IT investments undertaken by offensive IT firms tend to be more ambitious in terms of the expected returns, and naturally they are more risky because they often involve substantial organizational change. A firm will adopt an offensive stance if their goal is to leverage technology to compete more effectively or to raise the firm to a position of industry leadership.

As we will see in the following section, the distinction between offensive and defensive IT firms forms the foundation of McFarlan's strategic grid.

3.4 McFarlan's Strategic Grid

A successful business model aligns an organization with its environment, outlines the kind of resources that the firm wants to attract and capabilities to build in order to execute its unique business strategy. The alignment among the firm's competitive environment, business strategy, and capabilities is critical. McFarlan's Strategic Grid [102], is a framework which can be used to guide senior executives who aim to align IT and business strategy.

McFarlan's strategic grid suggests that the portfolio of IT projects that a firm undertakes can be evaluated along two dimensions: impact of IT on business operations, and impact of IT on strategy.

Classifying firms along these two dimensions - high/low impact of IT on operations or strategy - provides the following scenarios. For some firms the role of IT projects that the firm undertakes plays a critical role in their

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execution of the firm's strategy (high impact on strategy). The kind of IT projects that the firm undertakes are not likely to have an immediate impact on the firm's day to day operations.

On the other hand, firms may choose to focus on projects that have a high impact on the firm's day to day operations (high impact on operations). These kind of projects are more likely to help the firm sustain its current level of performance, but they are not likely to affect the firm's long term competitive position.

Combining these two dimensions defines the following four archetypes of IT impact or modes regarding role of IT in the firm: support, factory, strategic, and turnaround. These modes determine the approach that the firm uses to identify IT related opportunities, implement IT-enabled business initiatives, and manage IT resources and capabilities.

3.4.1 Support Mode or Support Quadrant

Support mode is at the intersection of a relatively low need for reliability and a low need for strategic IT. This means that IT simply supports employee's activities. Customers and suppliers don't have direct or indirect access to the firm's information systems. An IT interruption, e.g., server downtime or the Internet is not available, in a firm that is in the support mode may go unnoticeable by employees and customers, even if it lasts several hours.

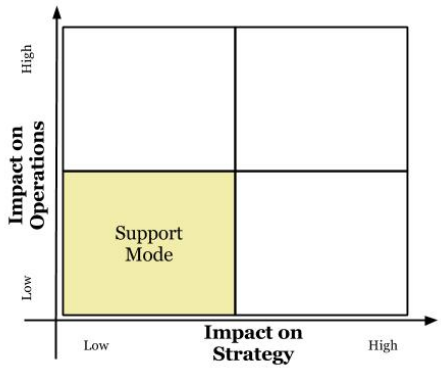

Figure 3.4: Support Mode

Perhaps the simplest example is that of a firm that produces agricultural or hand-crafted products. IT projects and initiatives that could be classified in the support mode of McFarlan's strategic grid have no impact in the firm's strategy or operation. Therefore, their management and execution is delegated to lower level management or IT specialists.

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3.4.2 Factory Mode or Factory Quadrant

Factory mode means that IT plays a very important role in the firm's operations (short-term effect) but its contribution to the firm's strategic position (long-term effect) is relatively low. Firms in factory mode need systems that are reliable and efficient.

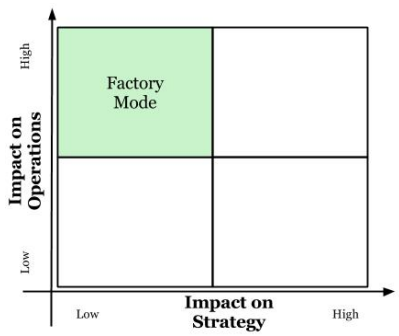

Figure 3.5: Factory Mode

Typically, these systems do not have to be the latest from a technological standpoint. As a matter of fact, given the critical role of reliability, firms in factory mode may choose to stay with a older version of a software or hardware till all bugs have been removed from the new version. Banks, airlines, e-retailers, and other firms that depend on their systems for the execution of almost all of their transactions belong to this quadrant.

IT projects undertaken by firms in factory mode aim to reduce cost (improve efficiency) and improve quality. While the benefits are operational, rather than strategic, senior business and IT executives are likely to be involved in the design and implementation because of their direct effect on operations and the high risk of an IT failure.

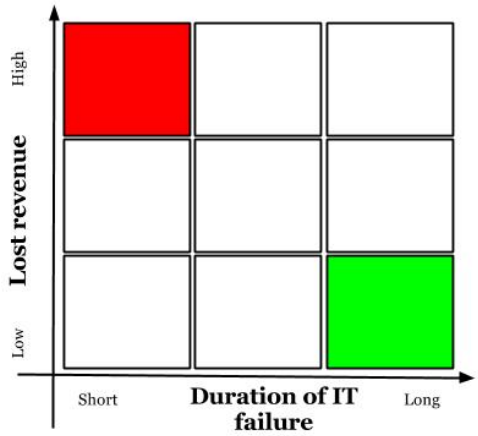

Figure 3.6: IT Failure & Revenues

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Customers and partners of firms that are in the factory mode interact directly with the firm's information systems. Bank customers use the bank's ATM network for cash withdrawals and deposits, and use the banks on line systems to check their balance, pay their bills, and monitor their investments. Travelers use the website of Travelocity or Expedia to make their travel arrangements. For companies in factory mode even the shortest disruption in their information systems translates into a disruption of operations and significant loss of revenue.

Figure 3.6 provides a graphical representation of the association between lost revenues and duration of an IT failure. Based on our discussion, we can conclude that firms, which are in the support mode, are very likely to cluster in the lower right area of Figure 3.6. On the other hand firms in factory mode are more likely to cluster in the upper left area of Figure 3.6. A firm's position in the 'lost revenue versus duration of IT failure' space has important implications for the portion of the firm's IT budget that will be allocated to ensure the security and up-time of the firm's systems.

3.4.3 Turnaround Mode or Turnaround Quadrant

Turnaround mode is positioned in the seemingly unorthodox combination of IT having a low impact on operations and high impact on strategy. The combination would look more meaningful if you were to consider a firm in the process of implementing an IT initiative that has the potential to transform the competitive landscape.

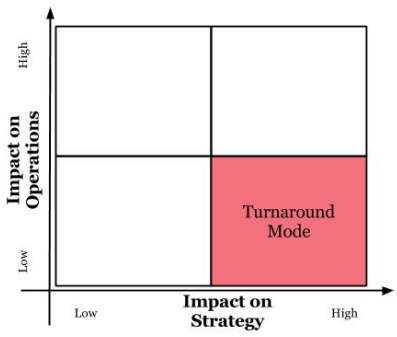

Figure 3.7: Turnaround Mode

Being in turnaround mode means that the firm is implementing a new information system but it relies on the old system to support the firm's day to day operations. The new system will not be used in the firm's operations till it has been fully implemented and carefully tested.

Therefore, the turnaround stage is a transition period when a firm is moving from the old system to the new one. Once the new system becomes operational the firm will exit the turnaround mode and move into the factory or strategic mode. IT initiatives associated with a firm's entry to turnaround mode tend to have

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the following characteristics:

1. They require substantial investment that can account to more than 50% of the firm's annual expenditures.
2. They have very high expected returns, i.e., promise of providing the firm with a competitive advantage.
3. The implementation risk is very high because such IT investments tend to require substantial change of the firm's business processes (i.e., business process re-engineering) and complementary investments.

Given the substantial upside as well as downside potential of such IT initiatives their planning and execution is allocated to senior level executives - quite often the company's CEO - and senior IT executives. If the investment requires technological expertise that are not available internally, it is very likely that the firm would enlist the services of large consulting firms (e.g., Accenture, Deloitte Touche Tohmatsu, Ernst & Young, IBM, Infosys, KPMG, and Tata).

3.4.4 Strategic Mode or Strategic Quadrant

Strategic mode means that the firm relies on IT innovation to perform its day to day operations (IT has high impact on operations) and in order to gain and sustain a competitive advantage (IT has high impact on strategy). As such it combines attributes from factory and turnaround mode.

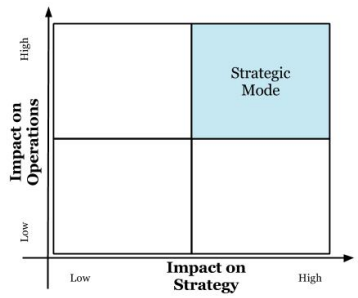

Figure 3.8: Strategic Mode

Firms like Harrah's Entertainment (now known as Caesars Entertainment), Walmart, FedEx, and P&G are known for their IT enabled competitive advantage and for their reliance of highly efficient and effective IT systems to support their day to day operations.

Firms which are in strategic mode tend to allocate a significant portion of the firm's overall capital expenditures in new IT projects. Given the strategic and operational importance of these projects it is quite common to observe a very close and synergistic relationship between the firm's CEO and CIO.

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3.4.5 McFarlan's Strategic Grid: Benefits

There are several benefits associated with the use of McFarlan's Strategic Grid (Figure 3.9):

1. It provides a simple framework that can be used to assess the alignment of individual IT projects with business operations and strategy.

2. Collectively, a firm's IT initiatives form its portfolio of IT projects. McFarlan's strategic grid can be used to evaluate the alignment of the firm's overall portfolio of IT projects with operational and strategic priorities. We will discuss IT portfolio management in Chapter 9.

3. From a strategic standpoint, a firm's relative performance is very important. McFarlan's strategic grid can be used to benchmark a firm's portfolio of IT projects with other firms in the industry.

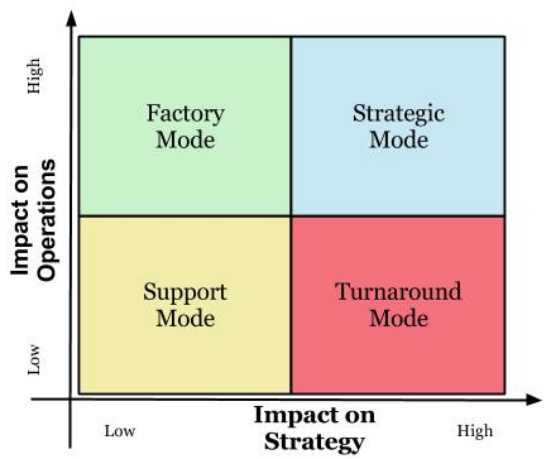

Figure 3.9: McFarlan's Strategic Grid

4. There is a difference between IT management (which deals with the day-to-day IT related decisions) and IT governance (which deals with such issues as who should be responsible for making IT related decisions and how to implement the firm's IT strategy). McFarlan's strategic grid can be used as a framework for developing the firm's IT governance at the board level.

Overall, the discussion of McFarlan's strategic grid stresses two things: First, we need to understand the role that IT plays within the firm. Second, the role of IT within the firm should be aligned with the company's strategic priorities.

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3.5 Alignment of Business and IT Strategy

Alignment between IT and business strategy has been one of oldest and thorniest IT related strategic issue that senior executives have been wrestling with. While there are numerous approaches that have been suggested over the years to analyze and evaluate the alignment between IT and business strategy, in this section we are going to focus on one that relates to McFarlan's strategic grid. To facilitate this basis of analysis, we are going to revisit our understanding of strategy and try to reposition it in a way that is more comparable to McFarlan's strategic grid.

As we have seen in Chapter 2, companies distinguish themselves from their competitors (i.e., gain a competitive advantage), by implementing any one of the following strategies:[5]

1. Deliver a product/service that customers value more than similar products/services offered by competitors. This means that the firm can charge a higher price.
2. Deliver a product/service of comparable value to that of competitors, but being able to produce this at a lower cost. This means that the firm is more efficient and operates at a lower average cost per unit.
3. Do both of them.

Regardless of the end result - higher price or lower cost - the source of the firm's advantage rests on the firm's ability to perform the host of activities associated with the production and delivery of the firm's products or services. Based on the above Porter [123, p. 62] makes the distinction between operational effectiveness and strategic positioning.

Operational effectiveness is defined as the ability to perform the same or similar activities with your competitors, but perform better than them. Firms achieve differences in operational effectiveness by investing in new technology, motivating employees, reducing defects, etc. Operational effectiveness translates to variations in profitability among competitors because it affects relative cost position and level of differentiation. While the pursuit of operational effectiveness is necessary for a firm to maximize its short-term profitability, it is not enough to ensure the long-term profitability. This means that a firm can gain a competitive advantage with operational effectiveness but the advantage cannot be sustained because competitors can quickly imitate the source of the firm's competitive advantage.

[5] The following discussion is based on Porter [123] and Tallon, Kraemer, and Gurbaxani [154].

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Strategic positioning means to either perform different activities from your competitors or perform similar activities in different ways. A firm's strategic positioning, i.e., its attempt to develop a unique strategy, can be based on the variety of the firm's products/services, customers' needs, and customers' accessibility.

1. Variety-based positioning, is chosen by firms that can produce particular products/services using distinctive sets of activities. For example, FedEx is known for its overnight express package delivery. Therefore, customers who use FedEx respond to its superior value chain for overnight package service. Compared to UPS, FedEx puts more emphasis on transportation based on jets.
2. Needs-based positioning, means that the firm will target and serve the needs of a specific group of customers. However, targeting the needs of customers by itself does not lead to value creation, unless the firm has a unique set of activities that can use to meet these needs.
3. Access based positioning, assumes that the firm has a unique set of activities that can leverage to serve the needs of geographically distinct group of customers.

Incorporating both dimensions, i.e., by contrasting a firm's focus on operational effectiveness (high or low) versus strategic positioning (high or low), we can generate the following four dimensions (Figure 3.10): Operational focus, strategic positioning focus, dual focus, or no focus.

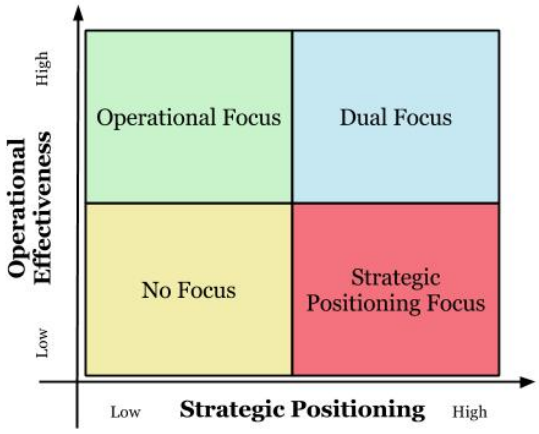

Figure 3.10: Operational Effectiveness v. Strategic Positioning

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Translating these four quadrants in terms of implications on competitive performance, we predict that firms with operational focus are likely to achieve either temporary competitive advantage or competitive parity, firms with strategic positioning focus are building their competitive advantage or enjoy a competitive advantage, firms of dual focus are likely to enjoy a sustainable competitive advantage, and firms with no focus are likely to be in a position of competitive disadvantage.

The corresponding and aligned goals for IT can be mapped according to these four quadrants:

1. In firms with operational focus, the goal of IT is on operational effectiveness. This means that the firm's IT projects and investments aim to reduce operating costs and to enhance the overall effectiveness of business operations by focusing on quality, speed, flexibility, and time to market. Recall that such objectives are associated with firms that are in factory mode in McFarlan's strategic grid.

   Senior executives of firms that choose to compete by focusing on operational effectiveness and adopt a factory mode view regarding the role of IT in the firm, seem to operate under the following assumption: If we use IT to gain greater control over internal processes, we will be better able to respond to environmental uncertainty and the emergence of new competitors. (*Q: Do you agree with the logic of this assumption?*)

2. Strategic positioning is similar to turnaround mode in the sense that once the firm has identified the kind of positioning, i.e., variety, needs, or accessibility based, the next step will be to achieve the necessary operational effectiveness in the appropriate unique value activities to support it. Firms with strategic positioning focus will use IT to create or enhance the value proposition to their customers. For example, they will try to leverage information systems to better differentiate among the different segments of customers in a way that supports the firm's evolving business model. IT initiatives that enable such a segmentation provide a better understanding of customers' needs and are critical for a firm with a strategic positioning focus. See the Side Note: Lady Gaga's Internet Strategy (p. 93).

3. Firms that belong in the dual-focus quadrant recognize that IT can be used for both operational effectiveness and for improving strategic positioning. The aligned IT strategy is that of strategic mode in McFarlan's strategic grid. Senior business and IT executives with aligned

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business and IT strategy, will choose IT projects that have a similar dual goal, i.e., revenue growth and efficiency (cost containment).

4. For firms that are in the no-focus quadrant, the lack of strategic priorities is likely to be reflected in similar no-focus on IT priorities. Stating that these firms are aligned with the support mode in McFarlan's strategic grid is not correct. A firm, that chooses to take an IT approach that matches to the support mode has made a rational choice. This choice reflects the realization that the firm does not want to compete in terms of IT and the firm realizes that IT is not critical for its operations. The firm simply chooses to be a follower in terms of IT investments. On the other hand, a firm that has low priority in terms of its focus on operational effectiveness and strategic positioning is a firm with not strategy. Firms without focus are not likely to remain viable.

Side Note: Lady Gaga's Internet Strategy ...

Lady Gaga's business manager, Troy Carter, will judge an eight-hour hackathon ... Geeks will vie to create new ideas to do with digital music distribution. The event will be hosted by Backplane, ..., which has just launched its first product, a web community for Lady Gaga called LittleMonsters.com (after the pop star's pet name for her fans). The goal is to create a one-stop shop for everything Gaga.

... Backplane is exploring the possibilities for mainstream brands, from Nike to ExxonMobil, to create virtual communities that foster deeper relationships with customers. (In the case of ExxonMobil, the likeliest passion for the firm to tap is not for petroleum itself, but for the different brands of car it powers.) The trick is to find those key influencers and amplify their voices. Mr Carter says that experience with Lady Gaga has taught him that what a super fan says can sometimes have a bigger impact on fellow fans than a word from the Lady herself.[a]

[a] 34.

Closing this discussion, we should remember that while IT strategy can either support or lead the firm's business strategy, it is critical that it is aligned with the firm's business strategy. Some professionals will go as far as suggesting that firms should integrate IT strategy within the firm's strategy (see Side Note: It's Time To Kill Your IT Strategy on page 94).

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The underlying assumption is that an organization that aligns its IT strategy with its business strategy; will derive a greater strategic use from IT, will achieve superior financial performance, and improve its competitive position.

It is possible that at some point, depending on internal and external conditions, an organization's business strategy may lead the IS strategy, while at another point the IS strategy may lead the business strategy. In general, for firms that seek to be IT leaders in their industry, it will be necessary for the IT strategy to be at the forefront of all other strategic initiatives. On the other hand, for firms that are unsure on how to generate value from large IT initiatives, it would make sense to allow the business strategy to drive IT strategy.

Side Note: It's Time To Kill Your IT Strategy

Does sound business strategy even exist today without technology? Most CEOs would likely agree that, unless you are running a lemonade stand, any successful business strategy must have solid technology at its core. The challenge for today's CEOs is that, while planning business strategy in isolation from technology is sub-optimal, it remains the most common way business leaders develop strategy. .. That's why Forrester [proposes] that there should be no IT strategy, just business strategy with a technology component, or BT strategy.[a]

[a] 41.

3.6 Payoffs from IT Spending - Part 2

One of the main take aways from early studies on payoffs from IT investment was the observation that the mere acquisition of an asset does not grant its owner a competitive advantage. In other words, it is a gross oversimplification to expect that simply spending more on technology will grant a firm a competitive advantage.

Starting in the mid-nineties the focus shifted from IT assets and IT resources to IT capabilities as a source of positive returns from IT investments. In strategic management a capability is described as a firm's ability to leverage its assets and resources in order to achieve a particular outcome.[6] Extending this definition in the area of IT, we realize that there are several stages that a firm will have to execute successfully in order to achieve the

[6] See the discussion on capabilities in Chapter 2 (p. 51).

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positive effect of IT spending on its financial performance. For example, a firm must invest in IT initiatives that are aligned with its strategic goals, the investments have to be implemented successfully and exploit the potential synergy with existing non IT resources and capabilities, and last but not least, the users should have the ability to extract the maximum value from these IT initiatives. In the following paragraphs we will explore some of these capabilities.

Effective Implementation Capability: The argument regarding the importance of effective implementation and use of IT rests on the fact that a significant percentage of all IT projects undertaken in any year will either fail during implementation or fail to meet their objectives. In 1994 a consulting company (Standish Group) produced the first in a series of *CHAOS* reports on IT implementation effectiveness. The focus of these reports was to identify ... "the scope of software project failures, the major factors that cause software projects to fail and the key ingredients that can reduce project failures." For the purpose of their study Standish Group surveyed hundreds of IT project managers.

They classified IT projects into three resolution types (categories) based on the project's assessment on budget, completion time, and functionality:

1. A project is deemed *successful* if it is completed on-time and on-budget, with all features and functions as initially specified.
2. A project is classified as *challenged* if it is completed and operational, but went over-budget and/or over the time estimate, and offers fewer features and functions than originally specified.
3. A project is classified as *failed or impaired* if the project was canceled at some point during the development cycle.

In spite the fact that they allowed for generous margins of error (variance) on the budget, completion time, and functionality, the 1994 Chaos report showed that 31.1% of projects were canceled before they ever get completed. Further results indicate 52.7% of projects would cost 189% of their original estimates.

More recent results (Figure 3.11) show some improvement, but the overall trend remains the same: IT project implementations tend to go over-budget, take more time to complete, and tend to deliver of the originally planned functionality. One of the main conclusion of these reports is that the cost of these failures and overruns are just the tip of the proverbial iceberg. The lost opportunity costs are not measurable, but could easily be in the trillions of dollars.

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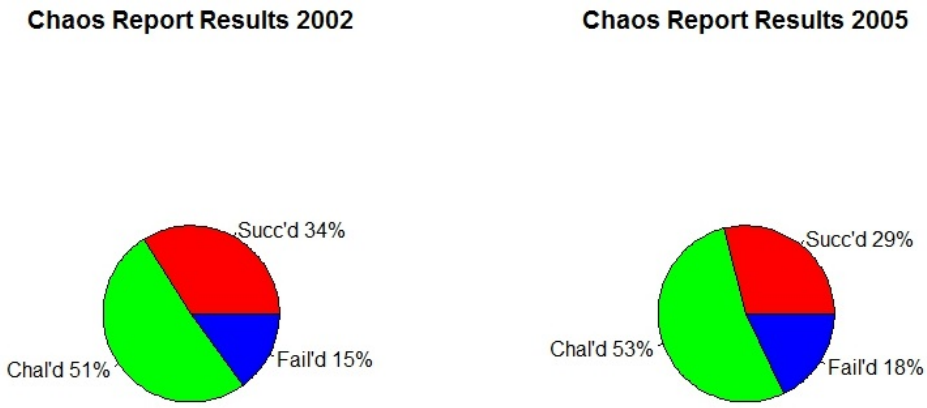

Figure 3.11: Chaos Report Results

Given this dismal implementation record, it is not surprising that empirical studies show little or no relation between investment in IT and financial performance. Obviously, users will not be able to extract value out of an IT project that either failed during the implementation or offers only a fraction of its originally planned functionality. Unless, the distinction can be made between successful and unsuccessful implementers and users of IT, it is quite possible to observe no relation or a negative relation between IT spending and financial performance.[7]

Organizational IT Capability: IT is a resource that generates competitive payoffs only when it leverages or enables pre-existing firm resources and skills. IT enables several organizational intangibles such as product quality, customer service, market orientation, knowledge assets, organizational memory, organizational learning, synergy, etc. For example while Customer Relationship Management (CRM)[8] systems are readily available in the market not all firms, which simply acquire these systems, will achieve the tight integration and coordination of the functional units required for efficient processing of customer information. Only firms in which the CRM is tightly integrated with management decision making, and the IS personnel that has a close working relationships with line managers to support their needs, will

[7] We will discuss issues related to implementation of enterprise information systems in more detail in Chapter 6.

[8] A customer relationship management system is an information system designed to organize, automate, and synchronize business processes related to marketing and sales.

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be able to achieve the necessary synergy to make the CRM a vital tool in the day-to-day running of the firm. These firms will become customer focused organizations.

A firm that can mobilize and deploy IT based resources (i.e., flexible IT infrastructure, human IT resources, and intangible IT enabled resources such as knowledge, synergy, and customer orientation) in combination with other resources and capabilities is an **IT capable firm**.

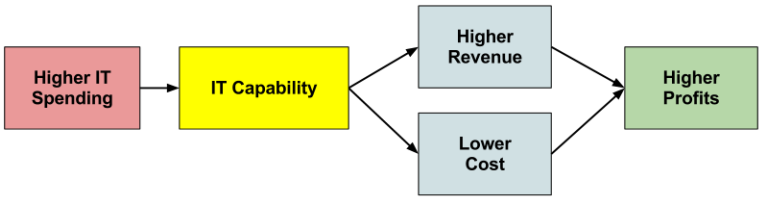

Figure 3.12: From IT Spending to Profitability - 2

Therefore, firms that spend in IT but fail in the implementation or are unable to extract value from IT, i.e., firms without an IT capability, will continue experiencing the IT productivity paradox. For these firms the mere acquisition of IT assets will not materialize in the form of superior financial performance. On the other hand firms that are successful in creating superior IT capability will enjoy superior financial performance by bolstering firm revenues and/or decreasing firm costs (Figure 3.12).

3.6.1 Revisiting Effect of IT Spending Relative Performance

Anderson, Banker, and Ravindran [2] argue that if IT spending generates competitive payoffs, this should be reflected in market valuation. More specifically, we expect that investment in IT would make the firm more profitable and more profitable firms are valued more (stock market).

A problem with the study of the IT productivity paradox is that firms are not required to report IT spending figures. However, for a brief period in the late nineties, the US Securities Exchange Commission (SEC) instructed publicly traded firms to report their IT costs associated with Y2K in their quarterly and annual reports.

Prior to the Y2K period for most companies IT was a cluster of isolated legacy systems designed to support specific business processes or functional areas.[9] Legacy systems did not support information sharing within the

[9] A legacy system is an old method, technology, computer system, or application program that continues to be used, typically because it still functions for the users' needs,

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organization (i.e., across departments or functional areas) or among the firm and its customers and suppliers (i.e., along the supply chain).

Many companies used the Y2K as an opportunity to replace their costly and rigid legacy systems with an enterprise resource planning system (ERP or ES) that had the potential to integrate the entire organization through a common database. According to a 1999 AMR survey, ERP spending absorbed 43% of the spending on IT applications and another 30% went to supply chain management (SCM) systems and customer relationship management (CRM) systems.

Investments in ERP systems have the potential to enable firms to form stronger links with their trading partners, i.e., customer and suppliers, develop a deeper knowledge of their customers, being able to mobilize resources and respond faster to changes in their competitive environments. In addition to these, ERP system implementations tend to be associated with changes in organizational processes and structures, worker knowledge and monitoring, and reporting and incentive systems.

Although resources such as the time it takes to redesign processes and train employees are devoted to these changes, accounting conventions do not allow the investment to be recorded as an asset. Therefore, the related investment contributes to the firm's unrecorded asset value. For these and several other reasons, that we will discuss in more detail in Chapters 6 and 7, these kinds of investments have the potential to increase the shareholder value of publicly traded companies.

Anderson et al. (2003) used Y2K related IT spending for 476 Fortune 1000 companies, to study the association between IT spending and firm valuation using the following model:

$$\textit{Market Value} = f\ (\ \textit{Book Value, Earnings, Y2K Spending}\ ) \tag{3.1}$$

A firm's shareholder value, which is stock price multiplied by number of shares outstanding, is a function of its book value, current earnings, and Y2K spending. The book value represents the net invested capital in the company; earnings represent the profit generated through the use of the firm's resources during the current period.

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even though newer technology or more efficient methods of performing a task are now available. A legacy system may include procedures or terminology which are no longer relevant in the current context, and may hinder or confuse understanding of the methods or technologies used. (Wikipedia)

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	1999	2000	2001	2002
Y2K Spending	**62.1**	**26.53**	**32.16**	**30.00**
Accounting Book Value	-0.03	1.76	1.85	1.91
Current Earnings	10.15	8.98	8.31	5.22

Table 3.1: Market Valuation Multiples for Y2K (IT) Spending

They found that shareholder value associated with Y2K spending was in fact many times greater than the spending itself (Table 3.1). They also found that this strong positive relation between shareholder value and Y2K spending persisted through the market downturn of 2000-2002. As shown in Table 3.1, the multiple on Y2K spending of 62.10 for March 31, 1999. This means that about $60 of firm value was associated with each $1 of Y2K spending.

These results are surprising in light of conventional wisdom that companies overspent on Y2K. At face value, the relation between shareholder value and Y2K spending suggests that improved productivity due to Y2K initiatives far outweighed their costs. Based on this the authors conclude that businesses actually under-invested in new IT during this period, thus presenting a new paradox that is the reverse of the initial productivity paradox.

3.7 Summary and Concluding Remarks

In this chapter we reviewed patterns in managerial perceptions regarding the role of IT in the firm. We analyzed some of the factors that drive decisions about whether or not IT plays a strategic role in the firm. We explored some of the most commonly encountered views based on the functional role of IT as well the firm's dispositions towards IT, and we used this as a foundation for understanding McFarlan's strategic grid. When it comes to IT strategy, McFarlan's strategic grid is the equivalent of Porter's generic business strategies. It provides a typology of IT strategies and a framework for evaluating alignment between IT and business strategy. We closed this chapter by revisiting the debate on the payoffs from IT investments.

While our focus in this chapter was on IT strategy, you need to keep in mind that about 39 percent of American companies do not have a formal IT strategy [139]. This means that for a lot of organization there is not a well-defined IT strategy on how to deal with new IT investments. Executives in these firms are not able to articulate their IT strategy. For these firms IT is

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more of on an afterthought.

3.8 Practice Questions and Problems

3.8.1 Study Questions

1. When it comes to managerial perceptions regarding strategic role of IT, is there a consensus that has emerged over time?
2. Is TMT's perception regarding the role of IT as a necessary evil or as leading edge dependant on whether a company is following a differentiation or cost leadership business strategy?
3. What are some of the factors that drive managerial perceptions? How is the state of the economy affecting these views?
4. If you were to scan a firm's annual reports, what terms would you use to gauge perceptions among the firm's TMT regarding the competitive rivalry that the firm is facing?
5. What is IT strategy?
6. What is the basis of competition? Can IT change the basis of competition?
7. Can IT change Porter's five forces and the factors driving them?
8. What is mass customization?
9. Provide an example of technological changes or information systems that had a a game changing effect in the context of Porter's Five Forces.
10. If Amazon succeeds in its quest to use drones for deliveries, how could this relate to the effect of technology on industry structure? Think about Amazon initiatives in terms of barriers to entry, backward integration (Amazon movies) and forward integration (Amazon delivery systems), distribution channels (drones), etc.
11. What are the expected payoffs associated with the three functional views of IT (automate, inform, and transform)?
12. Describe McFarlan's strategic grid by making the distinction between offensive versus defensive IT firms or offensive versus defensive IT projects.
13. Describe McFarlan's strategic grid by making the distinction among firms in Support, Factory, Strategic, and Turnaround mode or IT projects in Support, Factory, Strategic, and Turnaround mode.
14. What is the Strategic Grid and how does this relate to strategic Alignment?
15. Is there a consensus regarding the role of IT strategy relative to business strategy? Which one should drive the other one and why?

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16. What is Hyper-competition? What is the role of technological changes and how do they affect the competitive environment?
17. Smaltz, Sambamurthy, and Agarwal [140] argue that: " rather than providing competitive advantage through specific IT applications, today IT is viewed as a platform for enhanced automation, decision-making empowerment, control and coordination, and industry transformation ..."
    (a) Do you agree with the statement that specific IT applications do not provide competitive advantage? Explain your position and highlight accounting/financial implications.
    (b) What does it mean when the authors say that IT is a platform for enhanced automation?
    (c) What does it mean when the authors say that IT is a platform for decision making empowerment?
    (d) What does it mean when the authors say that IT is a platform for control and coordination?
    (e) What does it mean when the authors say that IT is a platform for industry transformation?
18. How does the following statement by Deming [29] relate to IT strategy and IT business value?

    > What is a system? A system is a network of interdependent components that work together to try to accomplish the aim of the system. A system must have an aim. Without an aim, there is no system. The aim of the system must be clear to everyone in the system. The aim must include plans for the future. The aim is a value judgment. (We are of course talking here about a man-made system.)

19. Generating a risk profile for the evaluation of new IT projects. In order to evaluate the profile of a new IT project you may want to consider the following two dimensions:
    (a) The firm's organizational IT capability, which can be high or low.
    (b) The expected payoffs from the new IT investment can be low or high. You can connect this one to the horizontal axis in McFarlan's strategic grid.

    Figure 3.13 provides a risk profile for new IT initiatives that uses these two dimensions. Based on your knowledge from the first three chapters could you explain the possible meaning/implications in terms of risk for each one of the four quadrants?

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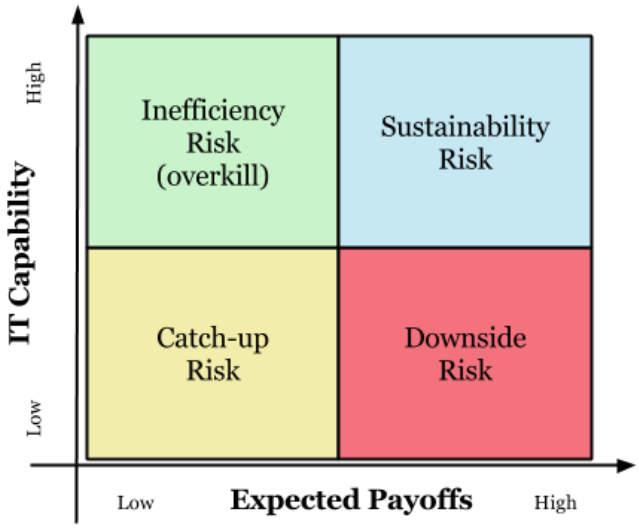

Figure 3.13: Risk Profile for New IT Initiatives

20. Summary Table - Relative Performance Payoffs of New IT Initiatives. The input-process-output model can be used to evaluate the effect of IT spending (input), via IT capability (process), on expected payoffs measured in terms of relative performance[10](output).
Figure 3.14 provides the foundation for this analysis. As you can see we have divided a firm's organizational IT capability into five components.

    (a) Justification refers to the disposition towards IT that the specific investment conveys to external stakeholders,e.g., investors. In other words is the firm's IT investment reflecting the position of a leader or a follower?
    (b) Alignment refers to the extent to which the specific initiative is aligned with the firm's strategic objectives and priorities.
    (c) Implementation refers to the firms IT implementation capability.
    (d) Use refers to the capability of the firms IT users to extract value out of this initiative.

    Using appropriate combination levels for each one of the four components of the firm's organizational IT capability try to establish the appropriate expected effect on relative performance.

[10]We discussed relative payoffs on page 38.

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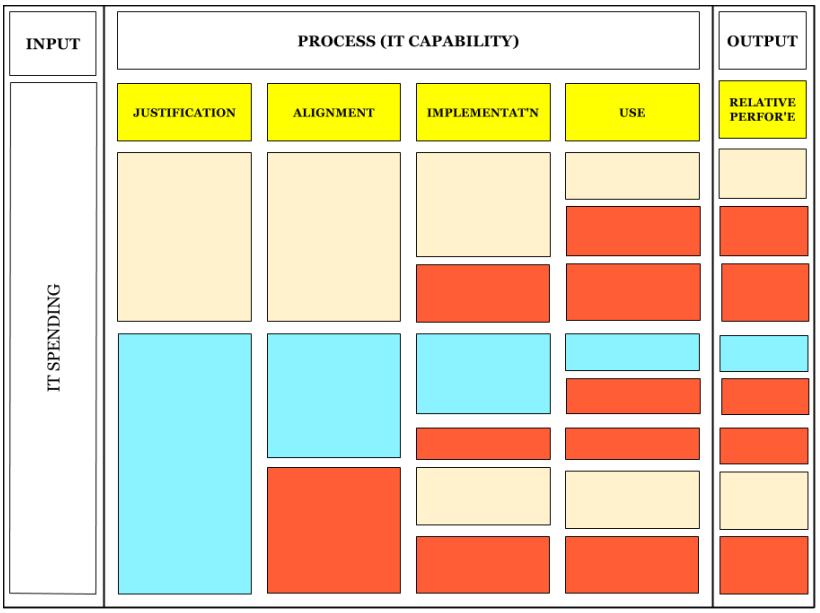

Figure 3.14: Summary Table - Relative Performance Payoffs

Mini-Essay The primary objective of the Deloitte & Touche and ING report "Achieving, Measuring, and Communicating IT Value," was to determine how companies utilize and evaluate the value of their IT investments.

According to the report, a firm should know its IT Value Profile. The authors of the report explain that the profile starts with a survey of both IT executives and enterprise business leaders on their views of the IT organization. They recommend asking business and IT executives a series of questions on topics such as planning, risk management, portfolio management and cost measurements. Based on the answers, the company establishes its IT Value Profile and is designated in one of the following categories:

1. Leader
2. Partner
3. Commodity

For example, if the survey responses indicate that the organization sees the strategic values of IT as high and the cost of IT as secondary to the business strategy, they'd be designated a Leader ... In addition to this a firm should understand its portfolio of IT investments. The authors explain

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that by understanding where in the portfolio their investments fall, CIOs can align their goals with business priorities ... The proposed portfolio management model divides IT projects into three categories of ascending risk and potential value:

- "Keep the Lights On" — core and non-discretionary spending
- "Advance the Ball" — enhancements and upgrades
- "Change the Rules" — applying new strategic IT tools.

The authors of the report conclude that once CIOs classify their IT portfolios by category, they can check to see whether their emphasis matches the IT value profile."

Question: Assuming that a firm's IT value profile falls in the category of "Commodity" and its IT project falls in the category of "change the rules"

1. Evaluate and explain the firm's Risk profile
2. Evaluate and explain the firm's expected relative performance (payoffs).

3.8.2 Multiple Choice Questions

1. In news article it was reported that "While it's clear that technological competence is critical in most industries, the variation in returns on IT investments is daunting. In retailing, for example, a CFO knows with some precision what an additional location will cost and how much revenue it is likely to generate. In contrast, an IT project's total cost could be off by an entire order of magnitude and its value either minimal or game changing. Senior executives at some organizations that have used IT less successfully in the past will probably throw up their hands and shut off all discretionary IT projects for the duration of the economic downturn." According to the story
   (a) During the recession companies with successful IT implementation history are more likely to decrease their IT spending
   (b) During the recession companies with unsuccessful IT implementation history are more likely to increase their IT spending
   (c) During the recession companies with successful IT implementation history are more likely to increase their IT spending
   (d) During the recession companies with unsuccessful IT implementation history are more likely to decrease their IT spending
2. In some firms, such as a local nursery, the impact of an IT failure of several hours or days would be neither immediate nor severe. In these

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firms we would expect to see a ___ portion of their investments directed towards IT, and the projects that they undertake are more likely to fall in the category of ___ mode of McFarlan's Strategic Grid.

(a) Small, Support
(b) Larger, Support
(c) Small, Factory
(d) There is not enough information to evaluate this question
(e) Large, Factory

3. A sentiment analytics based review of "managers' perception regarding the strategic role of IT over the years" has shown that perception ...

(a) has always been favorable towards new IT. In other words managers believe that IT innovation is a source of competitive advantage.
(b) has been unfavorable during periods of economic expansion and favorable during periods of recession. In other words managers believe that IT innovation is a source of competitive advantage during economic recession but not during expansion.
(c) has been favorable during periods of economic expansion and unfavorable during periods of recession. In other words managers believe that IT innovation is a source of competitive advantage during economic expansion but not during recession.
(d) has always been unfavorable towards new IT. In other words managers believe that IT innovation is not a source of competitive advantage.

4. "... some companies view IS as an enabler for innovation, while others view IS as playing a supporting role to automate existing business processes." Based on this we can argue that the first group are firms that fall in the ___ quadrant while the second group are firms that fall in the ___ quadrant of McFarlan's strategic grid.

(a) strategic, factory
(b) strategic, support
(c) turnaround, factory
(d) turnaround, support

5. Which of the following statement is correct?

(a) IT projects that aim to provide information to lower levels of the organization are likely to generate higher returns than projects that aim to transform an industry

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(b) IT projects that aim to replace human labor in automating business processes are likely to generate higher returns than projects that aim to transform an industry
(c) IT projects that aim to replace human labor in automating business processes are likely to generate lower returns than projects that aim to transform an industry
(d) IT projects that aim to provide information to higher levels of the organization are likely to generate higher returns than projects that aim to transform an industry

6. In a magazine article it was reported that [... The most basic cloud services work out of the box; for more complex software and database solutions, cloud computing allows you to skip the hardware procurement and capital expenditure phase - it's perfect for start-ups.] According to this article, cloud computing ...

   (a) reduces barriers to entry and reduces implementation risk
   (b) reduces barriers to entry and increases ability of users to extract value
   (c) is a large opportunity that requires a high ability to execute
   (d) is heterogeneously distributed among competing start-up firms hence a source of competitive advantage.

7. The time and effort that users have invested in learning how to use certain technology (known as human inertia) is an example of

   (a) how IT can change the basis of competition
   (b) how network effect works
   (c) how IT can change the balance of power between suppliers and buyers
   (d) how IT can affect switching costs

8. If a company targets small size of opportunities then the risk profile classification of its portfolio of IT initiatives will be in the category of ...

   (a) Sustainability risk or Downside risk
   (b) Downside risk or Catch-up risk
   (c) There is not enough information
   (d) Inefficiency risk or Catch-up risk
   (e) Inefficiency risk or Downside risk

9. If the motivation/justification of a company's IT investments is based on necessity (follower) and the company succeeds in terms of the im-

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plementation and adoption of the project by its employees. Then the expected outcome (performance) will be ___ .

(a) Competitive disadvantage
(b) Competitive parity
(c) Competitive advantage
(d) Downside risk.

10. The Deloitte and Touche portfolio management model divides IT projects into three categories of ascending risk and potential value: "Keep the Lights On" — for core and non-discretionary spending, "Advance the Ball" — enhancements and upgrades, and "Change the Rules" — for applying new strategic IT tools. The ability to execute is not included explicitly in the Deloitte and Touche portfolio management model. If we were to include the ability to execute in our analysis and we had two companies, one with High ability to execute and another with a Low ability to execute. Then in terms of a "Change the Rules" type of project, for the first firm it could have been a ___ and the for the second a ___ .

(a) Sustainability risk and quick win respectively
(b) Sustainability risk and downside risk respectively
(c) Downside risk and Sustainability risk respectively
(d) Downside risk and Inefficiency risk
(e) Mandatory Idea (Follower) and Sustainability Risk respectively

11. "[Cloud computing] is IT-as-a-Service. Instead of building your own IT infrastructure to host databases or software, a third party hosts them in its large server farms. Your company has access to its data and software over the Internet (which in most IT diagrams is shown as a cloud)." Based on this we can conclude that in terms of the effect on pay offs, ___ for cloud computing IT investments

(a) ability of employees to use is not relevant
(b) ability to implement and use is not relevant
(c) ability of employees to use is very important
(d) ability to implement is very important

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3.9 Business Analytics Practice Problems

3.9.1 Whirlpool & McFarlan's Strategic Grid

During ERP implementation, Whirlpool was in turnaround mode. The question is where will the company be once the project has been completed. One way of answering this question would be to try to capture the sentiment in the Whirlpool case [131]. You can do this as follows:

1. Review the material on factory and strategic mode, and make an initial list of keywords that you could associate with either factory or strategic mode.
2. Read the Whirlpool case [131] and as you are reading pay close attention for reference that could be related to keywords for factory or strategic mode. Count how many keywords you have associated with each mode.
3. Generate a simple 1×2 frequency table or a pie graph to summarize your results.
4. Tell a story based on your analysis.

3.9.2 Whirlpool & Role of IT

The focus in this exercise is to identify the perceived role of the ERP investment at Whirlpool. Your objective is to explore, whether and according to the case, this is an attempt to automate, informate up or down, or transform. Follow the same steps as in the previous exercise (3.9.1).

3.9.3 Whirlpool Financial Performance

The objective of this exercise is to calculate the payoffs from the IT investment (ERP) for Whirlpool over the period 1993-2013. We would like to see how WHR was doing prior to and after the ERP implementation.

1. Review the material on how to generate performance measures with Compustat data (pp. 303-307). For this exercise, we are going to focus on operating margin (om), asset turnover (ato), return on assets (roa), and days inventory (invdays).
2. Identify the Compustat variables needed to generate these ratios.
3. Extract the necessary for all competitors of Whirlpool data from Compustat for fiscal years 1993 to 2013, and save it as `csv` file.
4. Import your data in R and calculate the financial ratios.
5. Remove/set aside the WHR data.

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6. Generate descriptive statistics for all financial ratios. Observe their distribution and if necessary remove outliers.
7. Generate industry level confidence intervals for all financial ratios by year.
8. Merge WHR and annual industry data.
9. Create line charts for all ratios of WHR and industry averages.
10. Tell your story.

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Part II

Databases as a Foundation for Competing with Analytics

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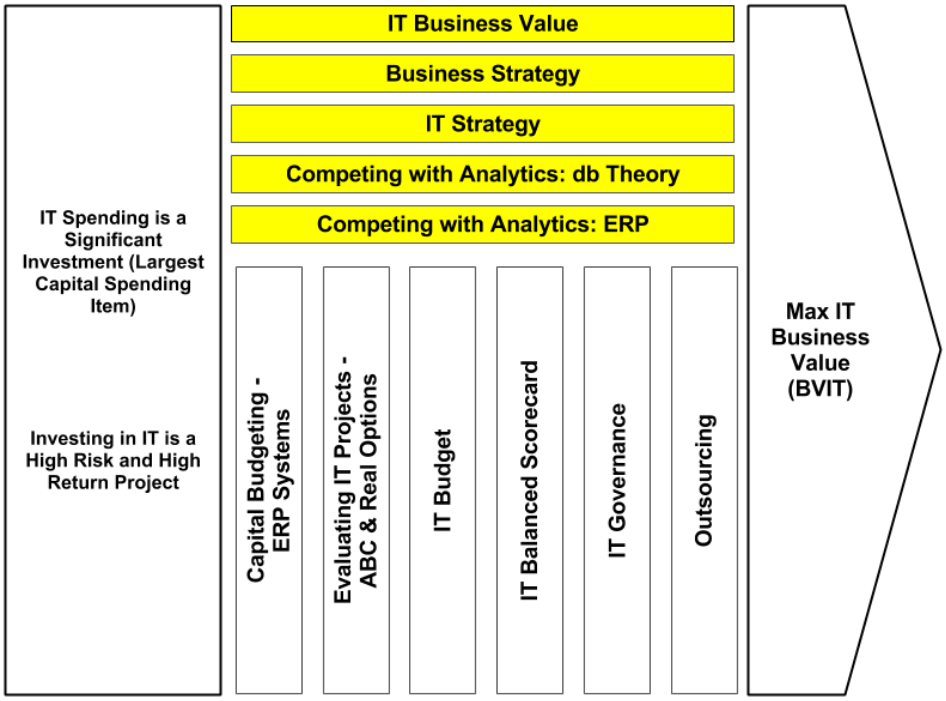
Chapter 4

Competing with Analytics

"In God we trust; all others must bring data." According to Wikipedia the quote is attributed to W.E. Deming, but there are no data to back it up.



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Learning Objectives

The objective of this chapter is to serve as the transition between part I (Business and IT Strategy) and part II (Foundation for Competing with Analytics). More specifically, we will start with an introduction to business/data analytics,[1] and use a historical and critical approach to explore and evaluate the role of business analytics at Harrah's Entertainment (in 2010 the company changed its name to Caesar's Entertainment). We focus on Harrah's because the firm has been known as one of the most innovative IT users.

The chapter serves a second purpose, that of preparing you for the discussion on database theory and enterprise systems. As you learn about business analytics and you read the story of Harrah's try to pay attention on the role that the creation of an integrated database, and by extension the creation of an integrated enterprise system, played in the firm's ability to compete with analytics.

By the end of this chapter, students should be able to describe, interpret, and apply the following concepts:

1. Define business/data analytics
2. Understand its role in different levels of decision making (operational. tactical, and strategic)
3. Understand the different level of business analytics and their use.
4. The association between analytics and business strategy.
5. The association between analytics and IT strategy (IT investments).
6. Key success factors for competing with analytics.
7. Specific objectives related to the case of Harrah's
   (a) What type of IT investments did Harrah's focus on?
   (b) What is the IT capability of Harrah's and how this capability evolved over time?
   (c) What is the firm's business strategy? Did this strategy change over time?
   (d) What is the firm's IT strategy? Did this strategy change over time?
   (e) What has been the role of IT on the firm's business strategy? Did this role change over time?
   (f) What were the risks and expected payoffs associated with the IT initiatives at Harrah's?

[1] In the rest of the chapter we use the terms business analytics and data analytics interchangeably or simply refer to them as analytics.

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(g) If you were to evaluate the IT contribution on the Harrah's relative performance which financial performance measures would you consider and why?

4.1 Introduction

"Well, in our country," said Alice, still panting a little, "you'd generally get to somewhere else - if you run very fast for a long time, as we've been doing."

"A slow sort of country!" said the Queen. "Now, here, you see, it takes all the running you can do, to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that!"[2]

Figure 4.1: The Red Queen's Race

As we have seen in Chapter 3 (page 80), changing and fragmented customer preferences, rapid technological changes, falling geographic and industry boundaries, and ability of firms to raise capital through global alliances have resulted in a state characterized by intense rivalry and difficulty for firms to sustain competitive advantage [25, 10]. This market state, which is known as *hyper-competition*, manifests in increased performance variations [56] and higher frequency of firms reporting losses [69]. The percentage of firms reporting losses has increased from approximately 15% in the 1970s to 35% in the 1990s, and over 40% in 2000s.

[2]Carroll [12] *Through The Looking Glass* (The Garden of Live Flowers)

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4.2 Analytics and Big Data

Success in such a hyper-competitive environment requires firms to seek out new knowledge to predict what customers will want in the future, and prepare to deliver it while anticipating the possible re-actions of existing competitors and new entrants. Like Alice in the Red Queen's race, many firms have to *'run faster'* to just stay competitive.

One means of staying competitive is by acquiring new knowledge, about customers and competitors, via significant investments in point of sale (POS) systems, customer relationship management (CRM) systems, supply chain management (SCM) systems, as well as social media (e.g., Facebook, Twitter, LinkedIn, and blogs) and media (e.g., magazines, newspapers, radio, and TV).

The proliferation of available structured data (e.g., data which is generated through the firm's transaction processing systems such as POS, CRM, and SCM) and unstructured data (e.g., data from Facebook postings, Tweets, video, and images) led to the introduction of a new term *big data*.

The term big data was first introduced by Cox and Elseworth [21] as follows:

> *Visualization provides an interesting challenge for computer systems: data sets are generally quite large, taxing the capacities of main memory, local disk, and even remote disk. We call this the problem of big data.*

Definition by SAS [134]:

> *Big data is a term that describes the large volume of data - both structured and unstructured - that inundates a business on a day-to-day basis.*

Definition by Gartner [49]:

> *Big data is high volume, high velocity, and/or high variety information assets that require new forms of processing to enable enhanced decision making, insight discovery and process optimization*

In simple terms all of the above definitions can be understood by referencing tools such as MS Excel and MS Access, which are used extensively in business settings. Therefore, big data could be visualized as a data set that could force the limits of these tools. For example, Microsoft Access only has a capacity of 2GB and Excel has a maximum of about a million lines.

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SAS has provided the following description for big data (Source: http://www.sas.com/en_us/insights/big-data/what-is-big-data.html): "*As far back as 2001, industry analyst Doug Laney (currently with Gartner) articulated the now mainstream definition of big data as the three Vs of big data: volume, velocity and variety.*

Volume. Many factors contribute to the increase in data volume. Transaction - based data stored through the years. Unstructured data streaming in from social media. Increasing amounts of sensor and machine-to-machine data being collected. In the past, excessive data volume was a storage issue. But with decreasing storage costs, other issues emerge, including how to determine relevance within large data volumes and how to use analytics to create value from relevant data.

Velocity. Data is streaming in at unprecedented speed and must be dealt with in a timely manner. RFID tags, sensors and smart metering are driving the need to deal with torrents of data in near-real time. Reacting quickly enough to deal with data velocity is a challenge for most organizations.

Variety. Data today comes in all types of formats. Structured, numeric data in traditional databases. Information created from line-of-business applications. Unstructured text documents, email, video, audio, stock ticker data and financial transactions. Managing, merging and governing different varieties of data is something many organizations still grapple with.

Many firms organize their data into data warehouses and analyze them with datamining tools, and rely on their findings to shape their business strategies and enable agile competitive moves. Collectively, this set of methodologies, processes, architectures, and technologies that transform raw data into meaningful and useful information used to enable more effective strategic, tactical, and operational insights and decision-making is known as business analytics (BA) or data analytics (DA).

In 2006, Davenport [27] published the book "*Competing on Analytics: The New Science of Winning.*" The book, which became a best seller, highlights how numerous firms, such as the Boston Red Sox, Netflix, Amazon.com, CEMEX, Capital One, Harrah's Entertainment, Procter & Gamble, and Best Buy, used analytics to build their competitive strategies. This, and the release of the movie *Moneyball*, have created a huge interest in analytics.[3]

[3]Moneyball the movie centers on the 2002 Oakland Athletics baseball team, who were led by general manager Billy Beane to an excellent season despite having the lowest payroll in the major leagues. In addition to scouting and more conventional methods of assembling a team, Beane introduced statistics and mathematical analysis into player evaluation, to the chagrin of many traditionalists. The movie is based on the book by Lewis [90]

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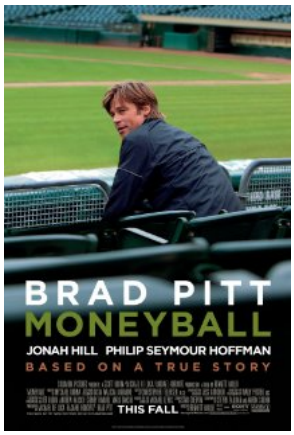

Figure 4.2: Moneyball

As the volume of data that firms capture is increasing, the appeal and the need for analytics tools is rising. Firms realize that they have captured huge amount of data about their customers, suppliers, employees, processes, etc. This data if properly analyzed can be used to fine tune existing strategies or develop new ones. Software vendors such as IBM Cognos, SAP BusinessObjects, Oracle, Tableau, Alteryx, and SAS understand this and they have rushed to fill the gap [59, 58]. In parallel there has been an explosive growth in use of two open source programming languages (i.e., Python and R). As a matter of fact these two languages are the two most popular tools among data analysts.

The growing demand and supply for business analytics has produced, among others, the following two results:

First, it has resulted in the democratization of data analytic tools. According to Henschen [58] new technologies (e.g., highly scalable data warehouses, low-latency integration techniques, and faster, deeper query and analysis capabilities) have become more affordable. As a result more and more, especially small companies are putting analytics tools in the hands of their front-line decision makers. These days field sales and marketing people are leveraging analytics in their planning, merchandising, and supply chain management.

Second, it has increased the incidents of firms that face significant competition from unanticipated competitors. A report by McKinsey [94] asks senior executives the following question: "*Are you ready for the era of big data?*" The following excerpt from this report makes this challenge more explicit:

> *The top marketing executive at a sizable US retailer recently found herself perplexed by the sales reports she was getting. A major competitor was steadily gaining market share across a range of profitable segments. Despite a counter punch that combined online promotions with merchandising improvements, her company kept losing ground. When the executive convened a group of senior leaders to dig into the competitor's practices, they found that the challenge ran deeper than they had imagined.*

Moneyball: The Art of Winning an Unfair Game.

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The competitor had made massive investments in its ability to collect, integrate, and analyze data from each store and every sales unit and had used this ability to run myriad real-world experiments. At the same time, it had linked this information to suppliers' databases, making it possible to adjust prices in real time, to reorder hot-selling items automatically, and to shift items from store to store easily. By constantly testing, bundling, synthesizing, and making information instantly available across the organization from the store floor to the CFO's office the rival company had become a different, far nimbler type of business. What this executive team had witnessed first hand was the game-changing effects of big data.

4.3 Analytics and Decision Makers

In very simple terms, the idea behind business analytics (BA) is that decision makers should look at all available data in order to understand what happened in the past, what is happening now, and what is likely to happen in the future, to support their decision making. Therefore, analytics could help decision makers at the operational, managerial or tactical, and strategic level.

At the operational level decision makers that could leverage historical data are the front line employees who provide the services, sell the products, or deal with customer related concerns/issues. Typical operational level decision makers, such as call center employees, tend to work with well structured information and rely on predetermined procedures in order to deal with routine transactions.

Operational level decision makers need BA tools that provide them with access to such information as customer's profile, history of purchases or complaints, available warehouse inventory, tracking systems, etc. They need tools that will let them process data and generate information/knowledge that will help them provide better service to their customers. In addition to this they will need performance related dashboards that they can help them monitor their performance over time and compared to their peers.

Decision makers at the tactical level can be managers of business units or departments. They tend to rely on semistructured information and summary reports that have been generated at the operational level. For example, they may have sales data (by salesperson, by day/week, by region, or by product) in order to decide what promotions to offer; supplier related information

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(orders, deliveries, returns, and back orders) in order to decide whether to assign allocation of preferred supplier status to one of their vendors, or partner related information (satisfaction of customer with installers or repairs done by independent contractors) in order to gauge whether choosing a partnership versus internal employees was the best choice.

In general tactical decisions are related to the allocation of firm's resources and the aim is to achieve the maximum return. Tactical level decision makers will look at patterns and trends that will help them monitor success and plan a short term course of action.

Decision makers at the strategic level are the firm's senior executives (e.g., CEO, CFO, and COO). They tend to rely on unstructured information, both internal and external, in order to deal with decisions that affect the firm's long term success and survival. For example, a firm's decision to enter into a new product market is likely to rely on summary reports that are based on its internal systems (e.g., marketing, operations, and accounting) in order to evaluate the firm's financial resources as well as its R&D, operational, and marketing capabilities. However, as we have seen in Chapter 2, this information will have to be complemented by competitive intelligence, that aims to assess the state of its competitors, as well as market analysis for understanding customers' preferences.

4.4 Categories of Business Analytics

4.4.1 Classification Proposed by INFORMS

There are two popular ways of classifying and organizing business analytics. The first one, introduced by the Institute for Operations Research and Management Science (INFORMS), proposes the classification of BA in three categories; descriptive, predictive, and prescriptive analytics.

descriptive analytics focuses on preparation and analysis of historical data in order to identify patterns and report trends. Several vendors (e.g., MicroStrategy, Tableau Visualization,, and SAS Visualization Analytics have generated packages that are specifically designed to support descriptive analytics and data visualization. The Shiny package in R enables users to create interactive dashboards (see Figure 4.3)

Predictive analytics focuses on the prediction of future probabilities and trends. The aim is to uncover patterns and trends that may not be apparent based on descriptive analysis. Business analytics is likely to rely on either traditional statistical analysis or data mining in order to predict behavior of a targeted audience.

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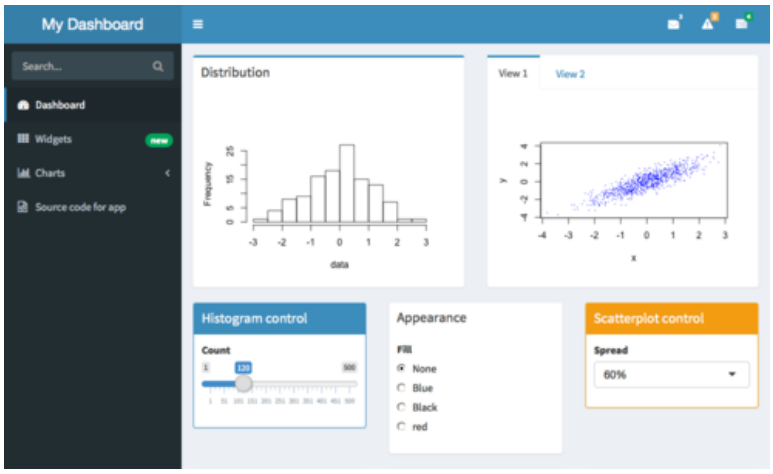

Figure 4.3: Interactive Dashboard with the Shiny R-package

There are countless opportunities for decision makers to leverage predictive analytics. For example, decision makers may use decision trees, logistic regression, or neural networks in order to predict which potential borrowers are more likely to default, credit card holders that will likely to carry a balance, or insured motorists more likely to have a claim. Marketers may want to perform cluster analysis in order to segment customers into different groups that are more likely to respond to a marketing campaign or market basket analysis in order to find customers purchasing patterns. This would be helpful if the marketer wants to bundle products that are likely to be purchased together.

The market for predictive analytics software has a relatively longer history and provides a combination of proprietary (e.g., SAS Enterprise Miner, SPSS Modeler, STATA, and Statistica) and open source packages (e.g., Python and R) for statistical analysis and data/text mining.

Prescriptive analytics is associated with the highest level of maturity in business analytics. While predictive analytics aims to tell us what will happen, with prescriptive analytics the focus is on what to do with this information. With prescriptive analytics the focus is on evaluating and determining prescriptions for new ways to operate and compete. These are analytics tools and techniques that aim to achieve optimization of a process or system. Given the nature of these applications, i.e., optimization, this type of BA is also known as decision or normative analytics. The search for oil and gas provides an example of how optimization (i.e., business analytics)

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is used in this industry.

> *... Producing oil and gas involves drilling and completing the wells, connecting them to pipelines and then keeping the flow of the hydrocarbons at an optimum rate, all integrally related to the subsurface environment. The path to optimizing production is dependent on the type of rock and structure of the reservoir. These decisions depend heavily on models created in the exploration phase. Today, every well that's drilled uses extensive machinery, measurement devices and people - all of which produce video, image and structured data. This area is probably the fastest growing in terms of the volume, variety and velocity of data being captured. Improving drilling and completion operations can significantly reduce costs. For reference, the widely publicized shale oil wells typically cost between $7 million and $10 million each. Offshore wells can cost tens or hundreds of millions of dollars. The cost goes up as the sea floor and the reservoirs deepen ... requiring more technology to do it safely and successfully.* [39]

While, for most advanced data analysts rely on programming languages, such as C++, one can solve optimization problems or perform what-if analysis with Solver, an add-on for Excel (See Figure 4.4) or leverage one of the R packages (`https://cran.r-project.org/web/views/Optimization.html`).

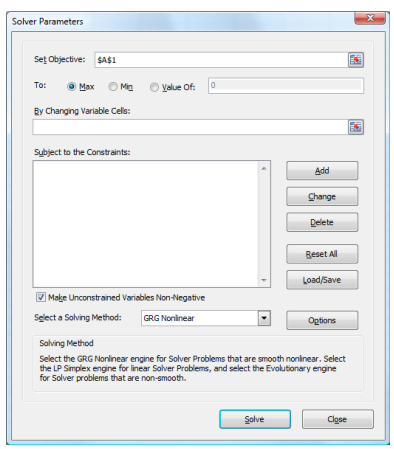

Figure 4.4: Excel Solver Menu

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4.4.2 Classification Proposed by SAS

The second classification system was introduced by SAS Institute and as you will see complements the INFORMS classification. SAS makes the distinction in terms of analytics that look into past activity and support reactive decision making versus business analytics that tries to predict the future course of actions and supports proactive decision making [133, 76].

Analytics that focuses on past activity can be further divided into four levels: standard reports, ad hoc reports, online analytical processing, and alerts.

1) Generating standard reports is the first level of BA. Monthly or quarterly reports provide summary statistics and try to help decision maker understand what and when events happened. For example, the manufacturing managers of Keystone Automotive Industries Inc. receive on a weekly basis (Monday morning) a three page multi color report that provides details on which car parts are on demand, e.g., car bumpers, so they can plan their production (Pratt 2006). Their usefulness is relatively limited by the fact that decision makers cannot modify them. In general, standard reports are not suitable for long-term decisions.

2) With ad hoc reports decision makers have a bit more control in terms of specifying the kind of questions that they want to ask. When it comes to understanding a past event they can ask specific questions such as "How many units did we sell in rural versus metropolitan areas? How often did this spike in sales occur last year? Where did we experience the largest growth or drop in sales?" Compared to standard reports they empower and provide decision maker with a level of independence.

3) The next level query drill-downs also known as on-line analytical processing (OLAP) allows decision makers to slice and dice the company's data, which is typically stored in a data warehouse - from many different perspectives and more importantly drill down into specific subgroups. This is suitable for situation when the decision maker wants to go beyond the result of a standard report or an ad hoc query.

The decision maker will use OLAP to make sense out of the results and find evidence to back up a potential explanation. Pivot tables, a standard feature in most spreadsheet packages, is an example of OLAP. For example, we can use Excel to generate a pivot table based on Compustat data that lets us see variations in ROA across industries (specified at the 3 digit SIC) and over time. As we will learn in chapter 5, Structured Query Language (SQL) is a very powerful tool for generating answers to such questions.

4) There are several ways that alerts can be introduced in a BA systems.

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The can be in the form of an email, tweets, RSS feed, or dials in a scorecard or dashboard. With them decision makers receive an alert indicating what actions need to be taken and when. Typical example is that of inventory level falling below a certain level, cost exceeding budgeted level, project is running late, or sales failing to meet their targeted level.

SAS has introduced the following four levels that can be associated with analytics that aim to support proactive decision making: statistical analysis, forecasting, predictive modeling, and optimization.

5) Statistical analysis such as frequency distribution, confidence intervals, and regression analysis are used in order to better understand why something is happening and what possible opportunities a decision maker may be missing or they should consider.

6) Forecasting is one of the most popular business analytics application. Considering the ripple effects of forecasted sales to practically any area within the firm, one can easily justify the popularity of forecasting applications. In its simpler former this may refer to trying to identify the basic trend behind a metric over time. More advanced techniques will rely on combination of regression and time series analysis.

7) While the term forecast and predict tend to be used interchangeably, SAS introduces predictive modeling as a separate form but there is not enough information in their report to justify this as a separate level. SAS provides the example of using clustering analysis or logistic regression to predict customers likely to respond to a marketing campaign or risk of leaving the firm. Collectively, the statistical analysis, forecasting, and predictive modeling are mapping into what INFORMS has classified as predictive analytics.

8) According to SAS, optimization supports innovation because it enables decision makers to find the best possible approach for dealing with a problem given the company's existing resource constraints. There are numerous opportunities for a firm to leverage optimization. For example, what is the best price to maximize our profits or what is the optimum discount strategy that the firm should consider for the sale of products with limited life cycle? See the story on p. 122 on how optimization is used in the oil and gas industry.

Revisiting BA Examples

In previous chapters we have seen several examples of how companies have used or could use BA. For example, you should revisit the story about the use of sentiment analytics at BestBuy on page 11. In order for BestBuy

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to perform this type of analysis they need to work with big data, i.e., data that is coming from many different sources. They have to combine structured data from the firms point of sales system with unstructured data from Facebook and tweets.

Once the data is in place they need to use text mining, i.e., they use software that relies on keywords, semantic structures, linguistic relationships, and emotionally charged words in order to extract patterns that indicate how customers feel about the company. Given the fact that these data is coming from various social networks, such as Facebook or blogs, they can establish the identity of the person posting the comment.

Using graph (network) theory they can assess how influential these people are within their network.[4] Finally from the company's transaction (sales) data they can assess the importance of the clients who are complaining on Facebook regarding re-stocking fees. A cost-benefit analysis could be used to establish the trade off between cost of restocking versus lost sales.

Similar approach for the case of RFID at Walmart

4.5 Harrah's: Anatomy of a Success Story

For two decades, Harrah's Entertainment has combined innovative IT strategies with business analytics to compete within the gaming industry. Harrah's was one of the first gaming companies to open casinos and riverboat-gambling venues outside of Nevada and Atlantic City when states began to liberalize their gambling regulations in the early 1990s [14]. Harrah's struggled, but lacked the financial resources to upgrade its facilities, when competitors began operating in these states and opening more attractive casinos, hotels, restaurants, bars, stores and shows [6].

Compared to its competitors, proportionately more of Harrah's revenues came from its casinos than from its shops, restaurants, bars and shows [14]. No longer able to differentiate itself geographically, Harrah's chose instead to differentiate itself through customer service. They aimed to attract and encourage patrons to spend more of their gambling budgets at Harrah's [14]. Since Harrah's already had the reputation as offering better customer service than other casino operators [Becker, 2003], improving service further required digging deeper into their data to learn how to improve customer rewards programs, pricing, and business processes. Harrah's leveraged a steady stream of IT investments and IT based innovations to build and improve customer loyalty. (Figure 4.5 shows one of the current hotels/casinos

[4] How does this relate to the story about Lady Gaga on page 93?

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owned by the company.)

Figure 4.5: Harrah's Las Vegas

In the following section, we will try to follow the company's evolution from the late eighties till approximately 2006, when the company went private. The company remained private from 2006 till 2010.[5]

4.5.1 Harrah's - Time Line

1988-1993 Automated player tracking technologies to capture slot machine and gaming table usage data had been around since the mid-1980s. In fact, Harrah's at Atlantic City was one of the first casinos to purchase slot machines designed to support automated player tracking [129]. These machines allowed firms like Harrah's to collect gaming related data.

In 1988, Harrah's CEO and VP of IT first conceived the idea of building a single nationwide database to learn more about its patrons. From a technological standpoint, this was a enormous and ambitious project. However, five years later, with competitive pressures increasing, the time was right to leverage investments that had been made to collect gaming data locally, in order to integrate all this data in a common company wide database.

American Airlines had introduced a frequent-flyer program in 1981 [79] and many casinos had rewards programs in which information was gathered

[5]The time periods listed at the headings of the following paragraphs are not exact. Some of the initiatives that started during a certain period may extend beyond the end of the period listed in the heading. In some other cases, in order to put things into perspective you may have to reference information outside the specific time period listed in the heading of the paragraph.

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and points awarded as patrons swiped their cards at slot machines, table games, and other casino facilities. However, automated tracking and rewards programs were local and information was not shared between casinos, even within the same chain. Harrah's recognized that integrating and analyzing gaming and other data from its 20 properties located across the United States [31] might let it know its patrons better and reveals ways to out market its rivals.

1993-1997 In 1993, Harrah's approved a $17 million project to build a national database, leveraging existing IT and slot machine investments, and introduce a national rewards card program [89]. Since companies cannot compete on information until the information is presented in standard formats, integrated, stored in a data warehouse, and made accessible [27], getting this first national database and rewards card program in the casino industry up and running was an important first step in getting to know its customers better.

In February, 1997, the national database was launched. One of the first findings validated the Pareto principle in sales, i.e., that about 80% of sales tend to be generated by about 20% of customers.[6] In the case of Harrah's data analysis confirmed that about 26% of gamblers were generating around 82% of the revenues. More interestingly, and contrary to popular belief that tends to associate casino revenues with high rollers, the typical customers were middle-aged and senior adults with significant discretionary time and income, who enjoyed playing slot machines [14].

1998-1999 In 1998, when Harrah's was still struggling and had become a takeover candidate [57], Gary Loveman, a former Harvard business professor with an extensive service management background, was appointed Chief Operating Officer (COO). The objective for the new COO was to maximize the benefits of the national rewards program.

The database had grown from 5.3 million customers in 1995 to 13.8 million by 1998 with the roll out of the national rewards card program [6]. By 1999, technology investments made to support sophisticated analytics, coupled with organizational changes, were paying off. Same-casino sales were up 14% from 1998 figures and increasing levels of repeat business were noticed [15]. Management used analyses of accumulated data from 18 casinos in the United States to direct marketing programs [113]. Loveman, wielding

[6]The Pareto principle or the 80/20 rule states that roughly 80% of the results in a distribution tend to be associated with about 20% of the drivers.

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power as the COO that he never could have exerted as a chief marketing officer, mandated use of reporting tools and systems by operational units [6], initiated casino experiments to demonstrate the efficacy of planned changes to casino managers [6] and re-staffing the marketing function with statistical experts [27]. Top IT executives served on the newly established marketing committee [6] and provided input on data strategy to support business intelligence and systems to deliver marketing programs at the earliest stages.

SideNote: Harrah's CEO (A)

Gary Loveman, the chief executive officer of Harrah's Entertainment Inc., the largest gaming corporation in the world, sees his customers as a set of probabilities wrapped in human flesh. First he considers the most basic set of probabilities, gender and age, since females are more regular gamblers than males and older women are the most lucrative demographic of all. Then he factors in where we live, what we do, how much we make, and, most important, how we wager and what we play when we come to one of his casinos. From those details, Loveman can divine to a remarkably accurate degree how much you, or the set of probabilities you represent, will be worth to Harrah's over the course of your lifetime.

Figure 4.6: Garry Loveman

"I am purely empirical," Loveman says in Bloomberg Businessweek's Aug. 9 issue, sounding like the former Harvard Business School professor he is. "I am not attached to any romantic notion of how this business should be run. I am only driven where the evidence takes me." Loveman is a unique figure in American business: an academic theoretician who made the transition to operating a multi-billion dollar corporation.[53]

By April, 2000, when Harrah's announced an enhanced three-tier national rewards program designed to further encourage customer loyalty, IT had systems collecting data about 19 million players in 21 casinos and was

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displaying patrons' accumulated reward credits at slot machines and on all primary direct-mail offers [114]. Growth in customer numbers was attributable to both the popularity of the national rewards program and casino acquisitions, Showboat Casino in Atlantic City in 1998 and the Rio in Las Vegas in 1999.

2000-2009: IT Innovations Tim Stanley, Harrah's VP of IT from 2001 to 2003 and CIO from 2003 to 2009, observed Harrah's 'success hinges on getting a steady stream of breakthrough tech-enabled gaming and hospitality innovations' [163]. Examples of Harrah's gaming industry innovations, other than its national loyalty program and predictive forecasting yield-management innovations, include the following:

- Integrating predictive modeling algorithms into Harrah's website 'to let customers cash in their rewards and book room online' [98];
- Automate blackjack and other table games by inserting radio frequency transmitters into gaming chips [62].

Figure 4.7: Ad for Gambling at Harrah's

- Optimized casino floor configuration [83] running visualization software on the data warehouse to connect slot machine performance with customer behaviors [112];
- Investing $100 million-plus in printers to be placed near gaming machines in 2004 [83] to permit real-time interactions, such as printing restaurant coupons that expire within the hour, when a losing streak is detected [45];
- Combining server-based gaming systems and video-based machines so that slot-machine games may be varied depending on the day of the

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week, time of day and popularity ([84], [45]); and

- Installing interactive touch screen displays on more than 60,000 slot machines to enhance real-time interactions and delivery of promotions and rewards to slot players [96], the players that can provide up to 80 percent of a casino's profit from gaming revenue [19].
- Instituted a points program for Harrah's staff (points based on customer satisfaction surveys redeemed through a website for products) [53].

4.5.2 Harrah's - Payoffs

Harrah's saw a 20% improvement in profits per room when it began using homegrown, patented, predictive modeling tool in September, 2001 [98]. The tool's proprietary algorithms predict lifetime yield based on demographic (age, sex, address), betting pattern (casino-game preferences, house advantage on particular game, average bet, number of bets per hour, and length of play), and other card-holder data (frequency of visits, overnight stays and restaurant visits) [6]. Predictive modeling makes it possible for companies to identify their most profitable customers and 'establish prices in real time to get the highest yield possible from each of their customer transactions' (Davenport, 2006). With the yield-management algorithms Harrah's offered the best room rates to customers most likely to spend a lot of money gambling.

Without the IT database and predictive modeling innovations, Harrah's would not have seen the 6% increase in the proportion of customers' gaming dollars Harrah's collects from 36% in 1998 to 42% in 2001 (Denison 2002) and to 43% by 2002 [32]. Since the national rewards program was introduced in 1997, making drilling down into detailed customer data possible, the firm enjoyed the following benefits: 1) Harrah's had saved more than $20 million in costs, 2) customers playing at more than one of Harrah's properties increased by 72 percent, and 3) the cross-market revenues increased from $113 million to $250 million [89].

4.6 Caveat Emptor

Harrah's is the quintessential example of a celebrity firm. Well orchestrated efforts by the firm's CEO (Garry Loveman) and CIO (Tim Stanley) led to numerous dramatized stories of Harrah's IT initiatives in academic journals, books, magazines, and news papers. Collectively, all these stories have created the firm's superior reputation for competing with business analytics.

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While the focus of this book and this chapters has been on IT, we should try to avoid falling into the trap of thinking that IT or IT enabled strategic initiatives are the only solution, to the firm's quest for competitive advantage. This chapter, we have seen numerous examples of how successful Harrah's has been in leveraging IT to support its main goal of competing with analytics. However, this is not the whole story. As the following excerpt indicates, at times a firm's strength (i.e., the way of thinking of its senior management) may become its Achilles' heal.

> *Worst Decision: Loveman's way with the numbers, he admits, can also be a weakness. It was responsible for the worst decision he has made as CEO, a mistake he's been trying to rectify for the past four years: his 2006 refusal to bid on a $900 million gambling concession – and one of just six gaming licenses – in Macau. He bought the golf course a year later in a belated attempt to get in on the action.*
>
> *"The quantification on Macau took me in the opposite direction," he said. "You had to have a kind of intuitive courage and I am not well suited to those kinds of decisions." Because he passed on the deal, Harrah's is for now locked out of the industry's most important emerging market. "Big mistake. I was wrong, I was really wrong."*
>
> *Missing Macau: Harrah's, and Loveman, are still paying the price. As Vegas swooned, Macau boomed to the point where competitors such as Las Vegas Sands and Wynn Resorts are now making more revenue in the coastal Chinese city than they do in Vegas. As rival CEOs Steve Wynn and Sheldon Adelson of the Sands made the decision to pile into Macau, the numbers told Loveman to stay out.*[53]

Evaluating celebrity or non-celebrity firms should always adhere to the same principles. First, identify relevant firm performance metrics. Second, evaluate the firm's (absolute) performance over time. Third, evaluate the firm's relative performance versus the rest of the industry and the firm's top competitors. See practice problem 4.9.4 on page 135.

4.7 Summary and Concluding Remarks

One of the main things that we have seen in this chapter is that there is a multitude of BA tools and techniques that can address the needs of decision

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makers in the firms front line (operational level) up to senior executives planning the firm's long term success. BA come in many shapes and forms; it can be a simple analysis of historical data to a very elaborate forward looking predictive model and optimization analysis. Decision makers can use BA to either disrupt the proverbial apple cart or respond to a disruption caused by their competitors. One thing for sure the make the competitive environment more dynamic. Examining the history of Harrah's provided us with numerous examples that can be linked to the IT business value proposition. Reviewing the IT investments at Harrah's made us realize how important databases are for competing with analytics. This will serve as our transition to the next topic which is an introduction to database theory

4.8 Practice Questions and Problems

4.8.1 Study Questions

1. Revisit the study question regarding the ethical concerns associated with the use of RFID by Walmart(Question 9 on page 29). What tools will you use to evaluate this question and why?
2. Get a copy of Tableau through the Teradata University Network[7] and use it to visualize some of the results that you have generated in previous questions (e.g., DuPont Analysis for Whirlpool)
3. What is the business strategy of Harrah's?
4. What is the IT strategy of Harrah's?
5. What is the reporting structure (CEO & CIO) at Harrah's? What are the pros and cons to having the Harrah's CIO to report to the company's CEO versus the CFO? We will revisit this question in Chapter 9.
6. What other kind of business (non-IT related events) may have affected the financial performance of Harrah's.
7. Two recent articles provide reference to an alternative direction for Harrah's.

   - The first one by Evans [37] states that Loveman would like to see Stanley "extend the revenue-creating potential" of existing applications and systems.

     Gary Loveman, CEO at Harrah's Resorts, says he needs his CIO to help him conserve cash in a business

[7] http://www.teradatauniversitynetwork.com/

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that loves to consume massive amounts of capital. Loveman also wants his CIO to find ways to extend the revenue-creating potential of existing applications and systems, such as Harrah's customer loyalty program, which started off focused exclusively on gambling but could become a platform for driving new revenue from shopping, dining, shows, and more.[37]

- The second one by Preston [126] is referring to T-Rex, a startup "that's extending the features of the Harrah's customer-loyalty program to external companies."

Both of these articles indicate that Harrah's is willing to sell, the source of its competitive advantage, to competitors. Do you think that this is a wise approach? Explain why.

8. What was the role of IT in the firm's M&As? You may want to use the following sources: Cone [19] has a side-bar listing Harrah's acquisition details. Greenfeld [53] has the more recent acquisition details.[8]
9. A 2005 article reports that the firm opened a $130 million data center in New Jersey to ensure data availability. Application and database servers can dynamically fail over to servers in the Memphis data center [64] . Using this information perform a graphical break even analysis of lost revenues and cost of back up systems. Create a graph that captures dollars of lost revenue due to an IT failure or dollars of cost associated with responding to an IT failure on the vertical axis and duration of IT failure or time to respond to an IT failure on the horizontal axis.

4.8.2 Multiple Choice Questions

1. Which of the following statements regarding Harrah's business and IT strategy in the 1990s is correct?
   (a) The firm developed its business strategy first and then implemented appropriate IT initiatives to support it.
   (b) There is not enough information in the case to evaluate the firm's business and IT strategy during this period.
   (c) The firm developed its business strategy and implemented appropriate IT initiatives at the same time.

[8]The corresponding complete reference for the paper of Cone [19] and Greenfeld [53] at the end of this chapter, includes the URL for accessing each one of these papers.

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   (d) The firm's business strategy and IT initiatives were not aligned during this period.
   (e) The firm implemented appropriate IT initiatives first and then developed a strategy that could leverage these investments.

2. Accountability for IT initiatives at Harrah's falls on
   (a) business managers.
   (b) the firm's CEO.
   (c) IT managers.
   (d) both business and IT managers.

3. During the 1993-1997 when Harrah's was implementing its national database the firm was in the ... quadrant of McFarlan's strategic grid. When the project was completed the firm moved to ... quadrant.
   (a) factory, strategic
   (b) turnaround, strategic
   (c) turnaround, factory
   (d) strategic, factory

4.9 Business Analytics Practice Problem

4.9.1 Firms Reporting Losses Over Time

On page 115 it was reported that the percentage of firms reporting losses has been on an upward trend. The objective of this exercise is to generate and contrast percentage of firms in the US versus the Canadian side of the wireless market over the period 2003 to 2016.

1. Data analytics problem 2.10.3 (p. 66) contrasts the industry structure of the wireless market in US versus Canada.
2. Based on the findings of this problem (2.10.3), what is your prediction regarding percentage of firms reporting losses between the two countries and why?
3. Generate percentage of firms reporting losses for each country and over time.
4. Tell a story based on your analysis.

4.9.2 Industry Structure - Harrah's

The objective of this exercise is to understand the external environment of Harrah's using Porter's five forces. You need to follow the industry structure

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over time (1988-2003). To complete this exercise you will have to complete the following steps:

1. Start by identifying how many of Porter's five forces you want to use and why? Your justification should reflect relevant information about Harrah's based on the text (pp. 126-130), news stories, or firm's financial reports.
2. Make a list of the accounting variables needed to generate these proxies and their Compustat code.
3. Find the four digit GIC for Harrah's and use it extract the data you need for all firms in this industry, and for the period 1990 to 2006.
4. Generate the industry structure proxies for each year in your sample period.
5. Generate appropriate summary statistics and/or graphs.
6. Tell a story based on your analysis.

4.9.3 Harrah's vs Competitors: Early Years

The objective of this exercise is to identify financial measures that could capture strategic choices made by Harrah's (In a way this exercise is a continuation or extension of the previous one). Read carefully, the discussion related to the early nineties for Harrah's (p. 125) and try to answer the following questions:

1. What is the problem that Harrah's was facing during this period? More specifically, what did the competitors do that Harrah's could not match?
2. If you were to use industry structure analysis, which of the five forces is relevant and why? What proxies will you use to demonstrate this difference between industry and Harrah's?
3. Leverage material from the previous problem to showcase your comparison of Harrah's versus the industry.
4. Tell a story based on your analysis.

4.9.4 Financial Performance of Harrah's

Based on the history of Harrah's, if you were to evaluate the payoffs of their strategy to compete with analytics, which accounting performance measures could you choose and why? Use these measures to evaluate the financial performance of Harrah's. in the period 1990 to 2006.

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1. List of measures that you considered (provide COMPUSTAT codes needed to calculate them).
2. Detailed justification for each one of your choices. The justification should reflect an accounting angle (i.e., how is the measure or ratio calculated, what is the intended use and interpretation) as well as a link to Harrah's relevant strategic and operational choices.
3. Perform a comparative evaluation over the period 1990-2006 of Harrah's versus the industry average in terms of each one of these measures. Tabulate/Graph and discuss your findings.
4. Create appropriate graphs to showcase your results and tell the story behind your findings.

4.9.5 Market Return - Harrah's

The history of Harrah's is divided in the following four periods (see pp. 126-130): 1988-93, 1993-97, 1998-99, 2000-2006. Each one of these periods is associated with a different stage in the firm's quest to develop and hone its business analytics capability. The objective of this exercise is to generate the market returns associated with Harrah's stock.

1. Extract monthly stock returns of Harrah's stock assuming a buy and hold strategy for the entire period.
2. Generate the cumulative returns for the entire, as well for each one of the sub periods
3. Generate annual returns.
4. Generate cumulative market returns for the entire period and sub periods
5. Generate annual market returns.
6. Summarize your finding and tell your story

4.10 Accounting/Finance Analytics Specialization

Should you consider adding business analytics tools to your accounting/finance toolbox? Lets start with a couple of facts:

First, while the rest of the company has just 'discovered' the importance of leveraging data in order to support decision making (i.e., business analytics), this is something that accounting/finance professionals have been doing all the time.

Second, while the rest of the organization has just discovered the importance of capturing and maintaining historical data, accounting/finance

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professionals have been doing this since the early sixties. Compustat, the database of financial, statistical and market information has been around since 1962.

Several accounting and finance professionals believe that the connection between the growing interest in business analytics and accounting/finance is not only an opportunity for accounting/finance professionals, but also a necessary condition for further adoption and growing legitimacy of business analytics across firms. Lets look at some of these arguments. Barry Melancon, president and CEO of the American Institute of CPAs, sees this an opportunity. Mr. Melancon argues that ...

> Big Data has increased the demand for information management specialists, while dramatically increasing the potential for visionary professional growth and positioning. *CPAs are perfectly suited to take a leadership role in deciphering and using Big Data to achieve strategic business goals.*[43]

In a recent meeting of the American institute of CPAs, D. Shimamoto, CPA, presented the following argument on why accounting/finance professionals should focus more on business analytics [55]:

> 1) "Information is everywhere, but it often lacks relevance, clarity, and accuracy. Surveys bear this out. Twenty-eight percent of senior finance executives said they had little or no information to predict the performance of their business in 2013, and another 54% said they had only half the information needed to provide visibility into performance, according to a recent Accenture survey. A recent Gartner report says that businesses are "still struggling to make progress with [business intelligence] and analytics." Accountants can help add clarity to the numbers.
>
> 2) Confidence in information is high when it comes from accountants. Satisfaction is lower regarding information supplied by some other departments. "The role of the accountant as a purveyor of truth and as an attester to the quality of the information has become increasingly important," Shimamoto said.
>
> 3) The rise in analytics represents an opportunity for finance to shift toward a role of business partner. The finance function has earned trust, but more for the role of watchdog and less for analytical insight. Accountants "can go beyond traditional cost control and start to evolve the role to be looking at the

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> organization as a whole and discussing how to best optimize the performance."Shimamoto said.

The importance of business analytics for the accounting and finance community is reinforced in a report from McKinsey & Company [94]. The report presents five ways in which firms can use business analytics (big data) to create value. As you read excerpts of this report below, notice how the role the Melancon envisions for the CFO and for accounting/finance professionals is aligned with the second of the ways of using business analytics.

> First, big data can unlock significant value by making information transparent and usable at much higher frequency.
>
> *Second, as organizations create and store more transactional data in digital form, they can collect more accurate and detailed performance information on everything from product inventories to sick days, and therefore expose variability and boost performance.* Leading companies are using data collection and analysis to conduct controlled experiments to make better management decisions; others are using data for basic low-frequency forecasting to high-frequency nowcasting to adjust their business levers just in time.
>
> Third, big data allows ever-narrower segmentation of customers and therefore much more precisely tailored products or services.
>
> Fourth, sophisticated analytics can substantially improve decision-making.
>
> Finally, big data can be used to improve the development of the next generation of products and services. For instance, manufacturers are using data obtained from sensors embedded in products to create innovative after-sales service offerings such as proactive maintenance (preventive measures that take place before a failure occurs or is even noticed).

A recent blog in Wall Street Journal [43] makes the potential benefits for the firm's CFO more explicit.

> ... Many CFOs know that the Big-Data tsunami is going to change their job. It will give them an opportunity to play an even *bigger role in their enterprises' strategic planning and decision making.* They will be asked for insights from departments that

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> once dismissed them as bean-counters. CFOs need to make sure that their organizations are ready to respond to these requests. They need to develop plans for hiring and training staffers. They need to be ready to advise other departments about who to hire to make use of this emerging technology. Most of all, the CFO has to help create a culture in which managers habitually use predictive analytics to make decisions rather than relying on experience and gut instinct alone. *Unfortunately, the skills needed to use Big Data are scarce.*

While Fuessler [43] states that there is a need for accounting and finance professionals with business analytics skills, you may wonder about the overall size of the market for professionals with business analytics skills. According to the McKinsey & Company report [94]:

> ... There will be a shortage of talent necessary for organizations to take advantage of big data. By 2018, the United States alone could face a shortage of 140,000 to 190,000 people with deep analytical skills as well as 1.5 million managers and analysts with the know-how to use the analysis of big data to make effective decisions.

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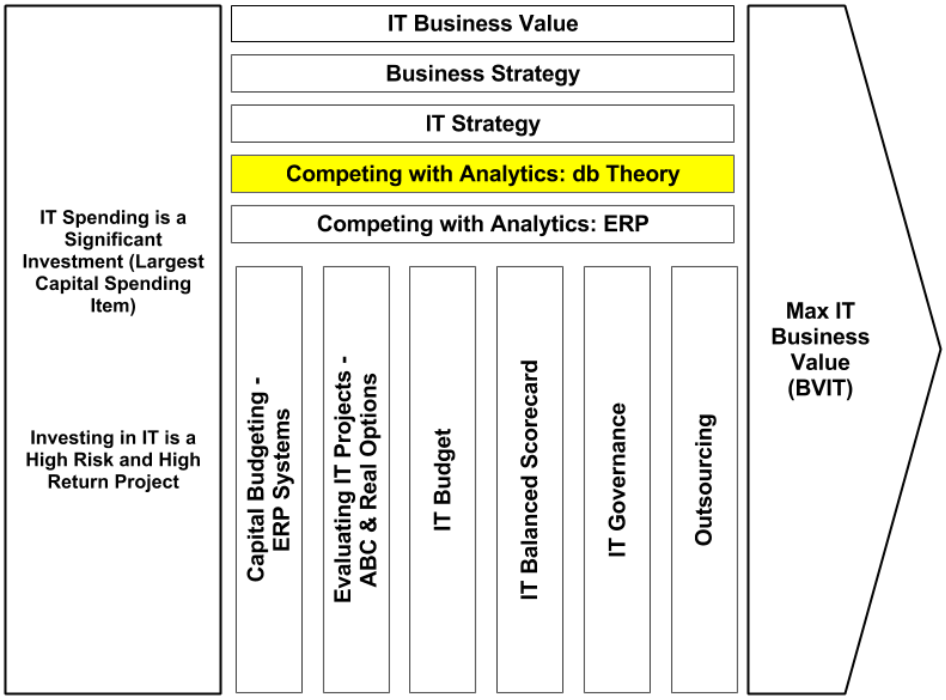
Chapter 5

Introduction to Database Theory

If I have seen further it is only by standing on the shoulders of giants - Sir Isaac Newton



Theophanis C. Stratopoulos, University of Waterloo

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Learning Objectives

By the end of this chapter, you should be able to describe, interpret, and apply the following concepts:

- Business processes; Order-to-Cash and Purchase-to-Pay
- Data vs. Information
- Relational database
- Database terminology, e.g., entity, attribute, occurrence, and associations
- Associations among attributes & associations among entities
- Primary and Foreign key
- Normalization and Normal Forms
- Entity relationship diagram

5.1 Business Processes

An analogy that has been used a lot is that of a database and a library. The analogy is based on the fact that while the library is collects and organizes book, which are a source of knowledge, a database collects and organizes data, which are a source of information. As the following excerpts from an article in the [35] "Lost in cyberspace," suggest, the destruction of the library of Alexandria implies the destruction of accumulated knowledge with dire implications for future generations.

... Amid the explosive growth of Internet services such as e-mail, music downloads and video streaming, along with the growth of the web itself, little thought has been given to recording information for posterity. The rapid turnover of content on the web has made total loss the norm. "Civilisation is developing severe amnesia as a result," says Stewart Brand of The Long Now Foundation. Danny Hillis, a pioneer of parallel computing and machine intelligence, fears the world has become stuck in a digital dark age, with few cultural artefacts from its digital past to point the way.

Lacking cultural artefacts, society has no mechanism to learn from previous mistakes. It is not hard to see where that can lead. The Library of Alexandria-built during the 3rd century BC to house the accumulated knowledge of centuries-reputedly had a copy (often the only copy) of every book in the world at the time. It burned to the ground sometime between Julius Caesar's conquest of Egypt in 48 BC and the Muslim invasion in 640 AD.

[The fire]*... destroyed many of the works of Aristotle, Aeschylus, Euripides, Sophocles and countless other ancient astronomers, mathematicians,*

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poets, playwrights and philosophers. All that remains today stems from a small fraction of the Alexandrian archives that had been backed up in a daughter temple called the Serapeum. Some historians believe the loss of the Alexandrian library, along with the dissolution of its huge community of scribes and scholars, created the conditions for the Dark Ages that descended across Europe as the Roman empire crumbled from within. A millennium of misery ensued, with ignorance and poverty the rule until the Renaissance dawned.

No one is saying that today's digital dark age portends any such disaster. Nevertheless, there could be serious ramifications for education, scholarship, government and even national security. All are legitimate concerns for the future.

From an organization's standpoint, a database plays a similar role. It is like a library that captures important information related to the company's employees, customers, partners, and their organization related actions. In this chapter, we will rely on a company named BlueBikes, which assembles and distributes bikes to retail bike shops. The company's database records, among others, sales of certain product (road bikes; model is RC Hybrid Whistler 10 2012 Large), to a specific customer (Rims in Motion), over a certain period (January through May 2013), by one the company's sales associates (Alpha Salespearson). Capturing this information is very important. It lets the management of the company evaluate which products are selling, how to manage the inventory, which customers are the most profitable, which salespeople are the most active, etc.

Stripping the company's management from this knowledge could send the company through the *dark ages*. Trying to manage and plan the company's future without this knowledge could take a toll on the firm's success. On the other hand, and as we have seen in Chapter 4, firms like Harrah's have collected and organized information about customers and their buying patterns. They can analyze these patterns to support the company's business strategy.

The main objective of this chapter is to introduce you to the basics of database theory. Given the fact that the vast majority of databases used by business today are relational, we are going to focus on relational database theory.

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5.2 Business Processes

The typical organization engages in various business processes such as purchasing inventory and making payments to suppliers, selling products and collecting payments from customers, and hiring employees. BlueBikes is a wholesale company that buys bikes, parts and accessories, as well as various kits for bikers in large volume from manufacturers. The company sells them to bike shops that are not large enough to purchase directly from the manufacturers.

One can classify the business processes at BlueBikes as customer or supplier based. On the customer side, the process of generating sales and collecting payments from customers, known as the Order-to-Cash process, includes the following activities:

1. Generate and record sales orders.
2. Ship content of orders to customers.
3. Send invoice for products to customers and record amount to be received.
4. Receive and record payments.

On the supplier side, the process of acquiring products from various vendors and making payments, known as Purchase-to-Pay process, includes the following activities:

1. Prepare and record purchase order.
2. Receive goods and record the receipt of inventory.
3. Receive invoice from vendor and record amount to be paid.
4. Submit and record payment.

Capturing data associated with each stage of these processes is very important as it provides the necessary information to evaluate the firm's ability to complete these processes efficiently and effectively. Ideally the data captured during a business process will be sufficient for someone in sales, marketing, accounting, or the warehouse to reconstruct all important steps of that business process. In order to meet these requirements the minimum data to be collected should capture/include information about the following elements:

1. All individuals or organizations involved in each activity. For example, name of salesperson, customer name, supplier name.
2. All assets that are exchanged as a result of this activity.

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3. All locations in which the activity took place; all locations where exchanged assets were before and after the event; and the location of all parties related to the activity during the activity and for future correspondence.
4. All the time periods related to the completion of the activity.

In the case of BlueBikes the Order-to-Cash process will start with a salesperson (Alpha Salespearson) generating a sales order from a customer (Rims in Motion) for certain products (5 road bikes; model is RC Hybrid Whistler 10 2012 Large) at a certain price ($1100 per bike). Alpha Salespearson should be able to look at the availability of the RC Hybrid Whistler 10 2012 Large in the firm's warehouse, and based on availability, establish a delivery date or determine whether the product should go on back order.

Finally, and after a quick look at the customer's credit limit to establish the terms of payment, Alpha will place the order on January 7th, and specify that the bikes will be delivered in the customer's store on February 1st. Recording the various components of this business process implies that we have already created a list of salespeople working for BlueBikes, as well as a list of customers and products.

In the warehouse, Beta Stockeroom will receive the packing list and shipping label. She will pick the bikes, package them, attach the shipping label, and send them to the customer. If the sale has brought the stock level of these bikes below a certain *safety level* a purchase order will be prepared, thus initiating the first stage in the Purchase-to-Pay process.

If all these data have been captured properly, the management of the company will be able to perform a sales analysis by salesperson, by territory, by product, by customer, and time period. Managers will be able to identify the most successful salespeople, the most profitable customers, the profit margins for each product, and accounts receivable and accounts payable.

This type of information is extremely important to businesses because of its use in decision-making, both for day-to-day operations and for strategic decisions that can alter the way a business functions. However, one cannot extract valuable information from bad, faulty data, or no data. A database management system (DBMS) is a program for capturing, accessing, and managing data. Therefore, a DBMS is the means by which BlueBikes can capture the necessary data that would provide the information for coordinating the activities of its functional areas and planning for the company's future. The following SideNote provides the brief description and makes the distinction between data and information.

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SideNote:Data vs. Information

While **data** are facts about people, places, things, or events, **information** is what you get when you process the data into something useful. Business data, such as facts about employees, customers, vendors, products, inventories, etc. are not of much use when they are collected in their raw form. As in the case of any raw material, it is often worth very little until it is processed into something of value. Data processing can yield information in many forms, such as summary tables, bar graphs, pie charts, plot points, etc. These processed data are in fact the basis for idea formation in many situations.

5.3 Relational Databases

Databases are usually designed to perform specific functions. As a result, there are several different kinds of databases. Two of the most common databases are **production** and **decision support system** databases. A production database is used mainly to track data about frequent and complex transactions. Each **transaction** involves one or multiple actions related to reading from or writing to a database. For example, when BlueBikes purchases a bike from one of its suppliers on credit, the accounts payable will have to be updated to reflect the amount outstanding, and the inventory account will have to be updated to reflect the increase by one bike. Whether it comes to buying or selling goods, or even enrolling in courses for the coming term, we encounter production databases on a daily basis.

A decision support system (DSS), on the other hand, is more complicated. Compared to a production database, it offers more extensive information generation and processing, as well as management capabilities. As a result, a DSS database focuses on the information requirements instead of the transaction requirements characteristic of production databases. The most popular DSS databases are called **datawarehouses**, which are primarily storage facilities dedicated to processing existing data taken from production databases into useful information. Datawarehouses tend to be updated rather infrequently compared to production databases, as they tend to have a lower volume of transactions to record. When data updates do occur, however, they are usually very significant.

When data is stored in a database, it is organized in certain ways that makes accessing and sifting through it easier. In addition to this, data about the data is also stored in the database. This data is referred to as

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metadata, which is kept in what is called a **data dictionary**. A data dictionary is a compilation of all the components of the data, their names, their characteristics, and also facts about the nature of relations between the different sets of data. A program that manages all this data and metadata is called a **Database Management System (DBMS)**. Essentially, the DBMS performs the following functions:

- Manages metadata in a data dictionary.
- Produces complex data storage functions, including enforcing data input requirements.
- Creates and enforces a secure environment for the storage of data.
- Manages the complex needs of a multi-user environment.
- Enforces data integrity at all levels of the database.

While there are several different database models/applications (e.g., Hierarchical, Network, Relational, and Object-oriented), the most prevalent by far is the **relational database**, implemented in the form of a **Relational Database Management System (RDBMS)**. Microsoft Access (Figure 5.1), Oracle, DB2 (IBM), Microsoft SQL, and MySQL (Oracle) are some of the most common database management systems. MS access is primarily geared towards singe users.

Figure 5.1: MS access

A relational database uses attributes to associate data from different tables. The relational database allows users to link sets of data in a tabular format, creating relations that are easy to visualize. Figure 5.2 provides a visual representation of an MS Access relational database that was designed to capture the sales process at BlueBikes.

Starting from the top (tCustomer) we can see that one of the customers is the company Rims in Motion. From the table orders (tOrders), we see that this customer with identification number (CID) 9 has placed an order on January 7th. The order has an identification number (ID) of 4. Using the order identification number (ID=4) we can see from the table of order line items (tOrderLine) that the customer ordered 5 units of the product that has a product identification number of 54. Using this product number we can look on the table of products (tProducts) and see that it corresponds to the bike package names RC Hybrid Whistler 50 2012 Large which is manufactured by Rocky Mountain and it sells for $1100.

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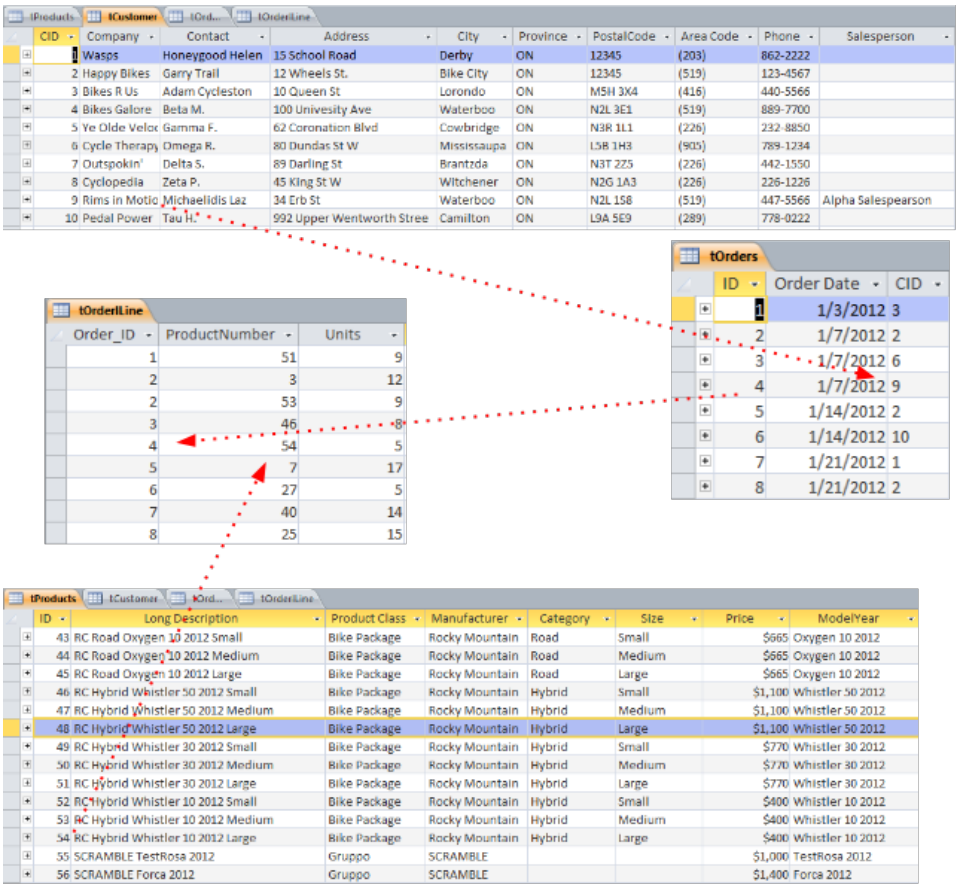
In the following section we will use this figure to introduce some of the terminology and basic theory of relational databases.



tCustomer

CID	Company	Contact	Address	City	Province	PostalCode	Area Code	Phone	Salesperson
1	Wasps	Honeygood Helen	15 School Road	Derby	ON	12345	(203)	862-2222	
2	Happy Bikes	Garry Trail	12 Wheels St.	Bike City	ON	12345	(519)	123-4567	
3	Bikes R Us	Adam Cycleston	10 Queen St	Lorondo	ON	M5H 3X4	(416)	440-5566	
4	Bikes Galore	Beta M.	100 Univesity Ave	Waterboo	ON	N2L 3E1	(519)	889-7700	
5	Ye Olde Velo	Gamma F.	62 Coronation Blvd	Cowbridge	ON	N3R 1L1	(226)	232-8850	
6	Cycle Therapy	Omega R.	80 Dundas St W	Mississaupa	ON	L5B 1H3	(905)	789-1234	
7	Outspokin'	Delta S.	89 Darling St	Brantzda	ON	N3T 2Z5	(226)	442-1550	
8	Cyclopedia	Zeta P.	45 King St W	Witchener	ON	N2G 1A3	(226)	226-1226	
9	Rims in Motio	Michaelidis Laz	34 Erb St	Waterboo	ON	N2L 1S8	(519)	447-5566	Alpha Salespearson
10	Pedal Power	Tau H.	992 Upper Wentworth Stree	Camilton	ON	L9A 5E9	(289)	778-0222	

tOrders

ID	Order Date	CID
1	1/3/2012	3
2	1/7/2012	2
3	1/7/2012	6
4	1/7/2012	9
5	1/14/2012	2
6	1/14/2012	10
7	1/21/2012	1
8	1/21/2012	2

tOrderLine

Order_ID	ProductNumber	Units
1	51	9
2	3	12
2	53	9
3	46	8
4	54	5
5	7	17
6	27	5
7	40	14
8	25	15

tProducts

ID	Long Description	Product Class	Manufacturer	Category	Size	Price	ModelYear
43	RC Road Oxygen 10 2012 Small	Bike Package	Rocky Mountain	Road	Small	$665	Oxygen 10 2012
44	RC Road Oxygen 10 2012 Medium	Bike Package	Rocky Mountain	Road	Medium	$665	Oxygen 10 2012
45	RC Road Oxygen 10 2012 Large	Bike Package	Rocky Mountain	Road	Large	$665	Oxygen 10 2012
46	RC Hybrid Whistler 50 2012 Small	Bike Package	Rocky Mountain	Hybrid	Small	$1,100	Whistler 50 2012
47	RC Hybrid Whistler 50 2012 Medium	Bike Package	Rocky Mountain	Hybrid	Medium	$1,100	Whistler 50 2012
48	RC Hybrid Whistler 50 2012 Large	Bike Package	Rocky Mountain	Hybrid	Large	$1,100	Whistler 50 2012
49	RC Hybrid Whistler 30 2012 Small	Bike Package	Rocky Mountain	Hybrid	Small	$770	Whistler 30 2012
50	RC Hybrid Whistler 30 2012 Medium	Bike Package	Rocky Mountain	Hybrid	Medium	$770	Whistler 30 2012
51	RC Hybrid Whistler 30 2012 Large	Bike Package	Rocky Mountain	Hybrid	Large	$770	Whistler 30 2012
52	RC Hybrid Whistler 10 2012 Small	Bike Package	Rocky Mountain	Hybrid	Small	$400	Whistler 10 2012
53	RC Hybrid Whistler 10 2012 Medium	Bike Package	Rocky Mountain	Hybrid	Medium	$400	Whistler 10 2012
54	RC Hybrid Whistler 10 2012 Large	Bike Package	Rocky Mountain	Hybrid	Large	$400	Whistler 10 2012
55	SCRAMBLE TestRosa 2012	Gruppo	SCRAMBLE			$1,000	TestRosa 2012
56	SCRAMBLE Forca 2012	Gruppo	SCRAMBLE			$1,400	Forca 2012

Figure 5.2: BlueBikes Relational Database - Visual

5.4 Database Theory & Terminology

5.4.1 Entity, attribute, & occurrence

Databases store data into tables, which are known as **entities**. A table may store data about a person, an object, a concept, or an event that a company wants to track. Typically, the table/entity is a noun (e.g., customer, supplier, order, or product) and we use the notation tCustomer, tSupplier, tOrder, or tProduct.

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- How many entities are in Figure 5.2?
- Name each one of them.

Each table/entity contains multiple columns which are known as **attributes** or **fields**. Given that an entity is a noun, you can think of its attributes as the adjectives describing this noun. What and how many entity attributes that you want to include in a database will depend on the specific entity and the nature of the company. For example, the entity customer in the BlueBikes database has the following attributes: CID (customer identification number), company, contact (person), address, city, province, postal code, area code, phone, and salesperson (who deal with this customer).

- What are the attributes of the entity Customer in the case of BlueBikes company? (See Fig. 5.3)
- Who are the customers in a university?
- Can you think of some attributes that may be relevant for BlueBikes but not for a university?

Each table has many rows which are known as **entity occurrences** or **records**. Each row contain information that describes a specific customer or supplier or whatever is the content of this table.

- Describe an entity occurrence in each one of the tables in Figure 5.2.

tProducts | tCustomer | tOrd... | tOrderLine

CID	Company	Contact	Address	City	Province	PostalCode	Area Code	Phone	Salesperson
1	Wasps	Honeygood Helen	15 School Road	Derby	ON	12345	(203)	862-2222	
2	Happy Bikes	Garry Trail	12 Wheels St.	Bike City	ON	12345	(519)	123-4567	
3	Bikes R Us	Adam Cycleston	10 Queen St	Lorondo	ON	M5H 3X4	(416)	440-5566	
4	Bikes Galore	Beta M.	100 Univesity Ave	Waterboo	ON	N2L 3E1	(519)	889-7700	
5	Ye Olde Velo	Gamma F.	62 Coronation Blvd	Cowbridge	ON	N3R 1L1	(226)	232-8850	
6	Cycle Therap	Omega R.	80 Dundas St W	Mississaupa	ON	L5B 1H3	(905)	789-1234	
7	Outspokin'	Delta S.	89 Darling St	Brantzda	ON	N3T 2Z5	(226)	442-1550	
8	Cyclopedia	Zeta P.	45 King St W	Witchener	ON	N2G 1A3	(226)	226-1226	
9	Rims in Motio	Michaelidis Laz	34 Erb St	Waterboo	ON	N2L 1S8	(519)	447-5566	Alpha Salespearson
10	Pedal Power	Tau H.	992 Upper Wentworth Stree	Camilton	ON	L9A 5E9	(289)	778-0222	

Figure 5.3: BlueBikes - Table Customers

5.4.2 Associations among attributes of an entity.

Figure 5.4 provides a list of some of the employees at BlueBikes company and their attributes. Association among attributes of an entity can be specified as either one or many. For example in the Employee table there is **a one association** from Employee ID (EID) to Name, Date of Birth, Date of

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Joining, Department, Designation, and Report To. There is a many association from department to employee name because more than one employees can be working for a given department.

Saying that there is a one association from A to B is known as a **functional dependency** and it is equivalent to saying that **A functionally determines B**. Therefore, A (EID) functionally determines B (Name or Date of Birth or Date of Joining or Department or Designation or Report To) *if and only if* there is a one association from A to B. This association is depicted as $A \rightarrow B$. Furthermore, if A functionally determines B ($A \rightarrow B$), and B functionally determines C($B \rightarrow C$), then A functionally determines C ($A \rightarrow C$).

tEmployee

EID	Name	Date of Birth	Date of Joining	Department	Designation	ReportsTo
EMP/0014	Beta Waterhouse	8/10/1980	11/8/2005	Warehouse	Warehouse Employee	Toshiro Mifune
EMP/0021	Max Headroom	7/4/1983	7/10/2007	Warehouse	Warehouse Employee	Toshiro Mifune
EMP/0027	Gamma Purchaston	12/16/1982	10/1/2005	Purchases and	Account Manager	Marcello Rubini
EMP/0037	Alpha Salespearson	9/22/1987	7/14/2009	Sales	Salesperson	Julia Redgrave
EMP/0038	Madame Souza	9/9/1948	2/14/2005	Main Office	Chief Executive Officer	
EMP/0039	Marcello Rubini	2/18/1976	10/12/2006	Purchases and	Manager	Madame Souza
EMP/0040	Julia Redgrave	10/27/1977	8/14/2008	Sales	Manager	Madame Souza
EMP/0041	Toshiro Mifune	4/13/1954	4/29/2005	Warehouse	Manager	Madame Souza

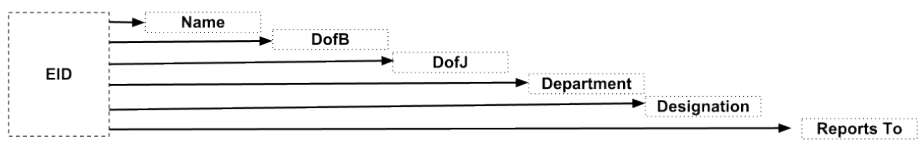

Figure 5.4: BlueBikes - Employee Table

5.4.3 Identifiers - Primary Key

If the value of an attribute can be used to uniquely identify an entity occurrence, that attribute can serve as the **primary key** of this entity. An attribute is unique if there are no two records that have or can have the same value for that particular attribute. By way of example, CID is the primary key in tCustomer, EID (employee identification) is the primary key in tEmployee. All tables must have a primary key.

- Is a person's name a good attribute to assign as primary key in an employee table?

Examples of primary keys that we often encounter are student numbers, SINs, employee numbers, and license plate numbers. These attributes can

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be used to uniquely identity a student, a tax payer, an employee, or vehicle. They uniquely identify the content of a record (row).

- What does this mean?
- Can you give an example based on Figure 5.2 and another one from the database of a university?

If you examine all attributes of an entity and none of them functionally determines all other attributes, then we can use a combination of two or more attributes in order to create a unique identifier for this entity. A primary key that consists of two or more attributes that combined uniquely to identify all other attributes is known as **combined** or **concatenated** primary key.

Figure 5.5 shows a sample of records from the table tOrderLine. The first column captures the order identification number, the second one the product identification number (also known as SKU, i.e., stock keeping unit number) for the products sold, and the third one records units sold.

tOrderlLine

Order_ID	ProductNumber	Units
46	63	11
47	48	4
47	52	7
47	56	11
47	58	7
48	19	9
48	22	7
48	31	8
48	35	5
48	37	12
49	37	9
49	40	6

Figure 5.5: Concatenated Primary Key

- Can order ID be the primary key of the table order line shown in Figure 5.5? Remember that for a field to be a primary key it must take a distinct/unique value each row.
- Can the product number be the primary key?
- Can the units ordered be the primary key?
- Does the combination of order ID and product number create a unique value in each row of this table?

In any given table, there are a number of combinations or single attributes that could be chosen as primary keys. However, from this list we choose and assign only one of them as the primary key. The remaining potential keys that were not selected are called **candidate keys**, and are usually not chosen due to some impracticality. It is easy to search for specific records in a table if one knows the primary key, but this is not always the case. For example, if you are searching for a specific employee in BlueBikes'

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employee table and you don't have their employee number (the primary key), you might search for them using their first or last name, or a combination of both. This key is called a **secondary key**, and it is not necessarily unique.

5.4.4 Associations Between Entities & Foreign Key

When we analyze the associations between occurrences of different table (entities) it is customary to refer to them as **relations**. A relation between any two entities is defined as a pair of associations that exist between the two of them. There are three type of relations, namely the **one-to-one (1:1)**, **one-to-many (1:M)**, and **many-to-many (M:N)**. It is important when we examine such relations to consider them in both directions.

One to Many relation If we look at the BlueBikes database (Figure 5.2) we can see that the association from tCustomer to tOrder is one to many. This means that one customer can place many orders, but occurrence of an order can be traced back to one customer. For example customer Happy Bikes has many orders. *How many orders from Happy Bikes are visible in Figure 5.2?* However, if we pick a specific order that was placed on 1/7/2012 this corresponds to only one customer (Happy Bikes). This means that if I know the order (invoice) number, I can **functionally determine** the customer that placed this order. Starting from the tCustomer side does not allow me to uniquely identify an occurrence of the tOrder entity.

- A class is divided in groups of five. You have created a database with two tables; one for students (tStudent) and another one for groups (tGroup). What is the relation between these two tables? Explain why.

When tables are linked through a one-to-many relation the primary key on the one side is repeated on the table on the many side of the relation. This repeating attribute is called the **foreign key**. The primary key that is repeating must come from the table on the one side of the relation.

Look at the tCustomer and tOrder of Figure 5.2 in order to answer the following questions:

- What is the primary key of the table Customers?
- What is the primary key of the table orders?
- What is the relationship between these two tables? Which table represents the one and which one represents the many side?

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- Does the primary key of the table customers repeat on the table orders? Why?

It is this repetition of the primary key that links the tables and allows us to retrieve data from multiple tables. We start by identifying an occurrence in one table and then use the value of the foreign key in order to search the other table for an occurrence that has the same value as the foreign key. In a relational database we must always be able to link related tables without referencing any information outside the tables themselves.

One To One relation A one to one relation (1:1) means that you can start from either A or B and uniquely identify the entry on the other side. Figure 5.6 shows such a relation. In this example we have the original employee table on the left and three more employee tables on the right. Each one of the new tables contains the original employee ID as well as a new field that shows the compensation method (salary, hourly wage, or commission). Each one of these new tables is a **sub-table** or **sub-class** of the original employee entity.

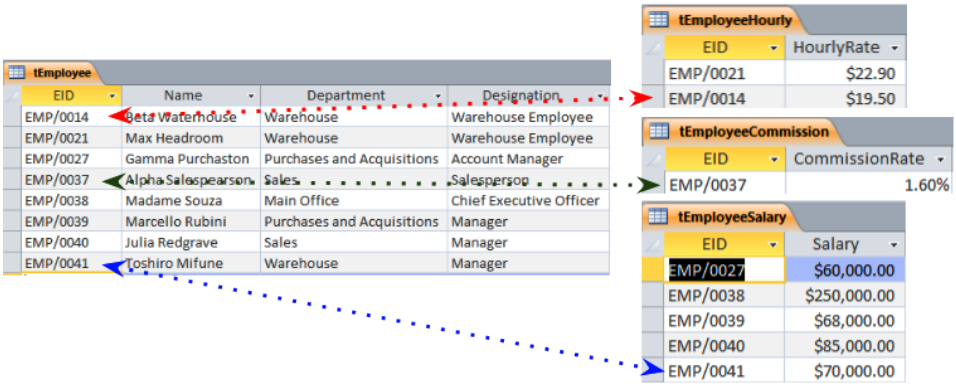

Figure 5.6: One To One relation among Employee Tables

In fact, entities that are linked to each other via a one to one relation can be represented by a single consolidated entity (table). We can consolidate the four tables into one by adding three new fields (salary, hourly wage, or commission) in the employee table. However this will results in a lot of empty or **null** values for these three fields.[1] *Why?*

[1] An important distinction between a null value and a blank must be made. Since a

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Many to Many relation A many to many relation (**M:N**) occurs when many entities on both sides are related to each other. These kinds of relations do not allow us to extend the chain of inference from one table to another. For example looking at the association between tProduct and tOrder (Figure 5.7) we can see that a product may appear in many orders and an order may have many products. Having the primary key of a specific product does not allow us to functionally determine specific values of attributes from the orders table such as order date and customer. Similarly having the primary key of an order does not allow us to functionally determine a specific product.

tOrders

ID	Order Date	CID
1	1/3/2012	3
2	1/7/2012	2
3	1/7/2012	6
4	1/7/2012	9
5	1/14/2012	2
6	1/14/2012	10
7	1/21/2012	1
8	1/21/2012	2

tProducts | tCustomer | tOrder | tOrderLine

ID	Long Description	Product Class	Manufacturer	Category	Size	Price	ModelYear
43	RC Road Oxygen 10 2012 Small	Bike Package	Rocky Mountain	Road	Small	$665	Oxygen 10 2012
44	RC Road Oxygen 10 2012 Medium	Bike Package	Rocky Mountain	Road	Medium	$665	Oxygen 10 2012
45	RC Road Oxygen 10 2012 Large	Bike Package	Rocky Mountain	Road	Large	$665	Oxygen 10 2012
46	RC Hybrid Whistler 50 2012 Small	Bike Package	Rocky Mountain	Hybrid	Small	$1,100	Whistler 50 2012
47	RC Hybrid Whistler 50 2012 Medium	Bike Package	Rocky Mountain	Hybrid	Medium	$1,100	Whistler 50 2012
48	RC Hybrid Whistler 50 2012 Large	Bike Package	Rocky Mountain	Hybrid	Large	$1,100	Whistler 50 2012
49	RC Hybrid Whistler 30 2012 Small	Bike Package	Rocky Mountain	Hybrid	Small	$770	Whistler 30 2012
50	RC Hybrid Whistler 30 2012 Medium	Bike Package	Rocky Mountain	Hybrid	Medium	$770	Whistler 30 2012
51	RC Hybrid Whistler 30 2012 Large	Bike Package	Rocky Mountain	Hybrid	Large	$770	Whistler 30 2012
52	RC Hybrid Whistler 10 2012 Small	Bike Package	Rocky Mountain	Hybrid	Small	$400	Whistler 10 2012
53	RC Hybrid Whistler 10 2012 Medium	Bike Package	Rocky Mountain	Hybrid	Medium	$400	Whistler 10 2012
54	RC Hybrid Whistler 10 2012 Large	Bike Package	Rocky Mountain	Hybrid	Large	$400	Whistler 10 2012
55	SCRAMBLE TestRosa 2012	Gruppo	SCRAMBLE			$1,000	TestRosa 2012
56	SCRAMBLE Forca 2012	Gruppo	SCRAMBLE			$1,400	Forca 2012

Figure 5.7: Many to Many relation

A many to many relation must be removed from the database design before its implementation. This can be done by creating an **intersection table**. Each record in an intersection table provides a 'bridge' that lets us relate a pair of occurrences of the original tables. In our example with the tOrder and tProduct, the tOrderLine table is an intersection table (Figure 5.8).

An intersection table may or may not have one or more attributes of its own. Whether the intersection table has or does not have its own attributes is not important. What really matters is that the intersection table must be created for the proper implementation of a database.

primary key must be unique, it can never be **null**, meaning that it has no value (the absence of a value), whereas a **blank** is represented by a space (which has an ASCII value), created by tapping the space bar. A null cannot be used to uniquely identify a record because it can have more than one meaning: The value does not exist; the value exists, but is unknown; the value is not applicable; the value is unknown, or inapplicable.

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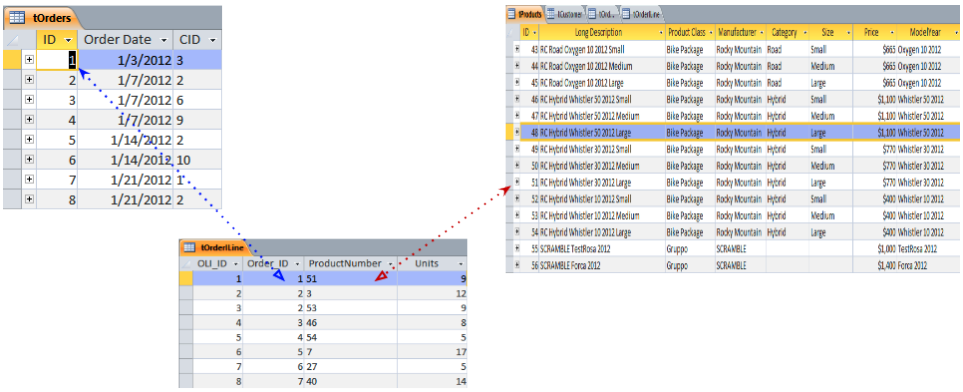

Figure 5.8: Many to Many with Intersection

Recursive Relation A **recursive** relation occurs when an entity is related to itself. Such an intra-entity relation we have seen in the employee table. In this table we have the list of employees and the reporting structure. This will allow us to see who is supervising who. Figure 5.9 shows how we capture the recursive relation in the employee table.

tEmployee

EID	Name	Date of Birth	Date of Joini	Department	Designation	ReportsTo
EMP/0014	Beta Waterhou	8/10/1980	11/8/2005	Warehouse	Warehouse Employee	EMP/0041
EMP/0021	Max Headroom	7/4/1983	7/10/2007	Warehouse	Warehouse Employee	EMP/0041
EMP/0027	Gamma Purcha	12/16/1982	10/1/2005	Purchases and	Account Manager	EMP/0039
EMP/0037	Alpha Salespea	9/22/1987	7/14/2009	Sales	Salesperson	EMP/0040
EMP/0038	Madame Souza	9/9/1948	2/14/2005	Main Office	Chief Executive Officer	
EMP/0039	Marcello Rubin	2/18/1976	10/12/2006	Purchases and	Manager	EMP/0038
EMP/0040	Julia Redgrave	10/27/1977	8/14/2008	Sales	Manager	EMP/0038
EMP/0041	Toshiro Mifune	4/13/1954	4/29/2005	Warehouse	Manager	EMP/0038

Figure 5.9: Recursive relation

- Can you think of other examples that could be captured with a recursive relation?

5.4.5 Cardinality

Cardinality refers to the maximum and minimum number of occurrences that must be included in a relation. When we establish cardinalities, the direction of the association matters. For example in a database that captures

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the relation between sales people and customers, we may have the following cardinalities:

1. Start looking at the relation as moving from the entity customer to the entity salesperson in order to establish the cardinality of the entity salesperson. 'Start' in this case means select a customer record and try to trace it back to a salesperson. From a business process standpoint, and from a logical standpoint, a customer is assigned at least to one salesperson and for a lot of companies at maximum to one salesperson. Therefore the minimum cardinality for the salesperson entity is 1, i.e., there is at least one salesperson that can be associated to a customer, and the maximum cardinality for the salesperson entity is 1, i.e., there is at most one salesperson that can be associated to a customer.
2. Start looking at the relation as moving from the entity salesperson to the entity customer in order to establish the cardinality of the entity customer. In this case we select the record of salesperson and try to trace back to one or more customers. From a business process standpoint, and from a logical standpoint, a salesperson may not yet have been successful at placing an order with a customer, but if we happened to pick a seasoned she or he may have hundreds of customers. Therefore the minimum cardinality for the customer entity is 0, i.e., the salesperson does not have any customers yet, and the maximum cardinality for the salesperson entity is many, i.e., there many customers that can be traced back to this particular salesperson.

5.4.6 Entity Relationship Diagram

The first step in the process of designing a database is to create a conceptual data model. That is, creating a model or blueprint that describes the structure of the data that will be stored in the database. A conceptual model focuses on how data will be represented, organized, and connected. During the design of the database we are not interested in specifying the values of specific data items. The **entity-relationship diagram (ERD)** or **entity-relationship (E-R) model** is the most commonly used data model designed to provide a description of a database in visual form.

A **relational schema** shows an ERD entity's relations by connecting foreign keys with their respective primary keys. The most prominent example of a relational schema is in the Relationships view in Microsoft Access. Figure 5.10 shows the ERD for sales module of the database of the BlueBikes company.

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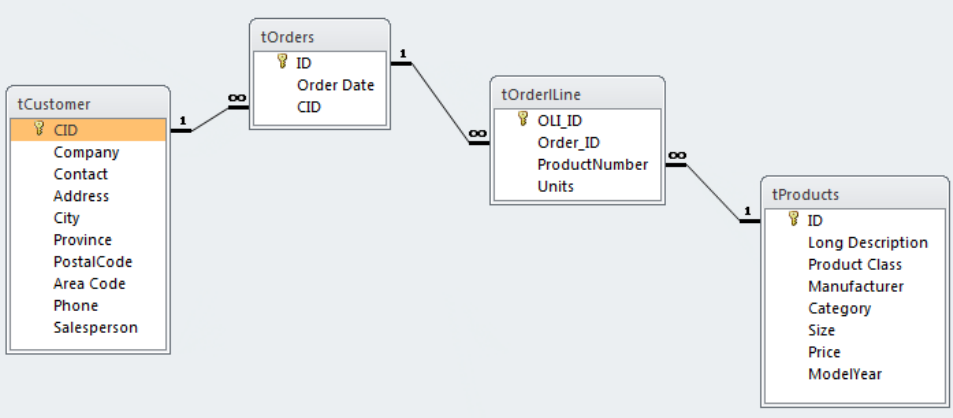

Figure 5.10: ERD of Sales Module with MS Access - BlueBikes Database

The ERD is a well-used and very prominent tool for designing production databases, which are based on transactions such as the sale of books, the payment of a loan, the enrollment of courses, etc. However, DSS databases used today are significantly more complex and require multidimensional information that cannot always be modeled in the form of an ERD. To address the inadequacy of the ERD in modeling these databases, a process known as multi-dimensional modeling was developed for data warehouse design.

5.5 Normalization

Consider what could happen to the BlueBikes' database if we were to capture capture employee education. If an employee has multiple degrees this will lead to problems in the EMPLOYEE table. One option could have been to repeat the employee record (add new record) to account for each degree. This option is shown in Figure 5.11.

An alternative could have been to a add a new column for each education degree. While for the vast majority of employees the education may be captured by a single entry, for some employees with multiple degrees we would have to add multiple columns that belong to the same domain (education). This option is shown in Figure 5.12, but as you can see employees like Marcelo Rubini and Toshiro Mifune are listed multiple times.

In either one of these options, our attempt to include the education attribute in the employee entity was problematic. Problems arise if, for example, an employee name had to be modified, and instead of having to update

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Name	Date of Birth	Date of Joining	Department	Designation	ReportsTo	Education
Alpha Salespearson	9/22/1987	7/14/2009	Sales	Salesperson	EMP/0040	
Beta Waterhouse	8/10/1980	11/8/2005	Warehouse	Warehouse Employee	EMP/0041	
Gamma Purchaston	12/16/1982	10/1/2005	Purchases and Acquisitions	Account Manager	EMP/0039	
Julia Redgrave	10/27/1977	8/14/2008	Sales	Manager	EMP/0038	Feminist Studies
Julia Redgrave	10/27/1977	8/14/2008	Sales	Manager	EMP/0038	Economics
Madame Souza	9/9/1948	2/14/2005	Main Office	Chief Executive Officer		Business Administration
Marcello Rubini	2/18/1976	10/12/2006	Purchases and Acquisitions	Manager	EMP/0038	Latin Studies
Marcello Rubini	2/18/1976	10/12/2006	Purchases and Acquisitions	Manager	EMP/0038	Accounting
Max Headroom	7/4/1983	7/10/2007	Warehouse	Warehouse Employee	EMP/0041	
Toshiro Mifune	4/13/1954	4/29/2005	Warehouse	Manager	EMP/0038	MBA
Toshiro Mifune	4/13/1954	4/29/2005	Warehouse	Manager	EMP/0038	Japanese History
Toshiro Mifune	4/13/1954	4/29/2005	Warehouse	Manager	EMP/0038	English

Figure 5.11: Employee Education - 1

Name	Date of Birth	Date of Joining	Department	Designation	ReportsTo	Education_A	Education_B	Education_C
Alpha Salespearson	9/22/1987	7/14/2009	Sales	Salesperson	EMP/0040			
Beta Waterhouse	8/10/1980	11/8/2005	Warehouse	Warehouse Employee	EMP/0041			
Gamma Purchaston	12/16/1982	10/1/2005	Purchases and Acquisitions	Account Manager	EMP/0039			
Julia Redgrave	10/27/1977	8/14/2008	Sales	Manager	EMP/0038	Feminist Studies	Economics	
Madame Souza	9/9/1948	2/14/2005	Main Office	Chief Executive Officer		Business Administration		
Marcello Rubini	2/18/1976	10/12/2006	Purchases and Acquisitions	Manager	EMP/0038	Latin Studies		Accounting
Max Headroom	7/4/1983	7/10/2007	Warehouse	Warehouse Employee	EMP/0041			
Toshiro Mifune	4/13/1954	4/29/2005	Warehouse	Manager	EMP/0038	MBA	Japanese History	English

Figure 5.12: Employee Education - 2

just one record, one would have to update each instance of the employee. This is known as a **modification anomaly**.

Another problem can arise if one needs to insert a new employee into the table who has four degrees, so their name will have to be repeated four times in the same table. This is referred to as an **insertion anomaly**. Finally, if that same overqualified employee finds a job elsewhere and needs to be deleted from the system, one would have to find each instance of his/her name and delete them, in an unnecessarily time-consuming process. This is known as **deletion anomaly**. From the above discussion it should become clear that the best way to avoid anomalies in databases is to avoid the M:N relation. You can do this by creating composite tables to break a potential M:N relation into two or more 1:M relations.

To avoid these problems, a database needs to be normalized. The goal of the normalization process is to organize the fields and tables of a relational database in a way that minimizes redundancy and dependency. Typically, the normalization requires separating large tables, like the Employee table, into smaller tables. Ideally we want additions, deletions, and modifications of a field to be done in just one table and then propagated through the rest of the database via the defined relations. In a normalized database the amount of redundancy should be eliminated or minimized. Normalization

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is the process used to create database designs that can be implemented effectively.

Order_ID	ProductNumber	Order Date	CID	Customer	Product Description	Units
463	12	12/31/2012	1	Wasps	DF Road Podium 5 2012 Large	14
464	54	12/31/2012	7	Outspokin'	RC Hybrid Whistler 10 2012 Large	5

Table 5.1: tOrderLine Normalization

Functional dependency (introduced on page 149) is very important for the normalization process. We will use Figure 5.1 to revisit functional dependency. First, you will need to notice that in this table, we have a combination primary key. Both 'Order_ID' and 'Product Number' make the primary key. In this table, some attributes cannot be determined unless one knows the entire primary key. Both 'Order_ID' and 'Product Number' must be used to determine the number of units sold ('units'). On the other hand, one could determine the customer name from the Order_ID and the product description from the Product Number. These are examples of **partial dependency** - one that is based on only part of a primary key. Another kind of dependency exists between the CID (customer ID) and customer name. In this case, the determinant (CID) is not even part of the primary key. This is an example of **transitive dependency**.

The introduction to partial and transitive dependencies is important due to their use as indicators of the presence of data redundancies. A **data redundancy** exists upon the meeting of the following two criteria:

- Multiple values of an attribute exist within a table.
- The multiple values are not necessary in establishing relations between tables. Therefore, multiple foreign key values do not imply a redundancy because they are required to establish relations between tables.

5.5.1 The Normal Forms

Now that data redundancy and anomalies have been introduced, the process of normalization can be discussed. The goal of normalization is to reduce the aforementioned redundancies by rendering a table into what is called a **normal form**, the category of which is determined by the type of dependencies that might still exist.

First Normal Form (1NF) This is the most important of the normalization steps. If the tables of a database do not meet the conditions for

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Student ID	Name	Dorm	Class 1	Class 2	Class 3
1	Alpha	North Village	AFM231	AFM241	AFM271
2	Beta	South Hall	AFM27	ECON211	
3	Gamma	Central Tower		AFM241	AFM27
4	Delta	North Village	AFM231	ECON221	AFM27

Table 5.2: Normalization - 1NF Example

1NF the database will have serious problems. 1NF imposes the following requirements:

- Tables have properly specified primary keys.
- Tables are 'flat,' i.e., tables have no repeating columns/fields or groups of repeating fields.
- Repeating fields must be moved to a separate but related table.
- Each row and column intersection (cell) contains only one value.
- Each table's attributes are dependent on the primary key.

A simple test that you can do to ensure that a table is passing the 1NF condition is to see if you can describe the content of (data captured in) a table with a single noun. For example it is impossible to capture or describe the content of Table 5.2 with a single noun. he table captures information about students, their dorms, and their classes.

Second Normal Form (2NF) The second normal form requires that a table that already meets all the conditions for 1NF, does not have any partial dependencies. You can remove partial dependency from a table by ensuring that 'nonkey' fields, i.e., fields which are not candidate keys, are fully dependent on the value of a primary key. Given the source of the problem (partial dependency) the 2NF is a problem in tables that have a composite primary key. The primary objective of second normal form is to avoid data redundancy in your tables.

- What is the primary key in Table 5.3?
- Can you identify any partial dependencies in this table?

Third Normal Form (3NF) The third normal form requires a table that already meets all the conditions for 1NF, and does not have any transitive dependencies. The 3NF requires that data in all 'nonkey' fields are fully

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Student ID	Term	School	Course	Prereq	Antireq
1	S2012	SAF	AFM231		BUS231W
1	S2012	SAF	AFM241	AFM102	CS330
1	S2012	SAF	AFM271	STAT211	AFM272
2	S2012	SAF	AFM241	AFM102	CS330
2	S2012	SAF	AFM271	STAT211	AFM272
3	S2012	SAF	AFM241	AFM102	CS330
3	S2012	SAF	AFM271	STAT211	AFM272

Table 5.3: Normalization - 2NF Example

Student ID	Name	Dorm	Dorm Cost
1	Alpha	North Village	5000
2	Beta	South Hall	3500
3	Gamma	Central Tower	6000
4	Delta	North Village	5000

Table 5.4: Normalization - 3NF Example

dependent on the value of the primary key. For example in table 5.3, one can specify the school as well as course prerequisites and anti-requisites based on course number. Obviously, course ID is neither a primary key nor a candidate key.

- Can you identify any transitive dependencies In table 5.4?

5.6 Structured Query Language

While most of the examples that we have used are based on how firms use databases to capture and store data, the real value of a database rests on the information that we can extract from these data. SQL (Structured Query Language) is a standardized programming language commonly used to manage relational databases. The ability to leverage SQL to extract appropriate data from a large relational database and transform these data is one of the most basic steps of data analytics.

Continue reading chapter 2 of the "**Basic Audit Data Analytics with R**" by Stratopoulos and Sheilds [153] to learn how to write queries. The book

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is open source and it is available from the following link: https://ssrn.com/abstract=3142207. More specifically the chapter shows how auditors use SQL commands (queries) in performing Audit Data Analytics (ADA). These commands enable the auditor to obtain and analyze particular subsets of data relevant to achieving the objectives of the ADA being performed.

5.7 Summary and Concluding Remarks

In this chapter we looked at the basics of database theory. While, it is unlikely given your career path that you will have to build your own database, you will spend a significant part of your time on the job working with databases. Knowing the underlying theory or the logic behind a data base will make you a power user and it will increase your ability to extract value out of this IT investment.

Looking back on Figure 5.2 you will notice that this database covers the sales process of the company. Obviously, we could continue adding more and more processes (e.g., procurement, payroll, inventory) until we have reached the point that for all practical purposes we have captured the entire company. If you can picture such a database, you will have a very good understanding of the topic of the following chapter, i.e., enterprise systems. As you will see, they rest on a database that has been designed to capture transactions and processes across an entire company.

5.8 Practice Questions and Problems

5.8.1 Study Questions

1. How does Newton's quote "If I have seen further it is only by standing on the shoulders of giants" apply to databases?
2. Identify and describe a business process.
3. Outline the stages of an Order-to-Cash and Purchase-to-Pay.
4. What is the difference between Data and Information?
5. What is the difference of Production versus Decision Support System databases? What is a data warehouse?
6. Define and provide an example for each one of the following terms: Entity, attribute, occurrence, and associations.
7. Define and provide an example of association among attributes. Define and provide an example of associations among entities.
8. Define and provide an example of a Primary and Foreign key.

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9. Describe the stages of the normalization process.
10. Describe data redundancy and data anomalies.
11. Define and provide an example of the 1NF, 2NF, and 3NF.
12. Explain how a database can be used in auditing.
13. Design a simple database the captures firms and their financial information over several years (i.e., design the main module of the database behind Compustat).
    (a) How many tables will you make?
    (b) What are the fields, primary and foreign keys in each table?
    (c) What is the association among the tables in your database?
14. Explain in simple terms the issue(s) and implication(s) shown in Figure 5.13

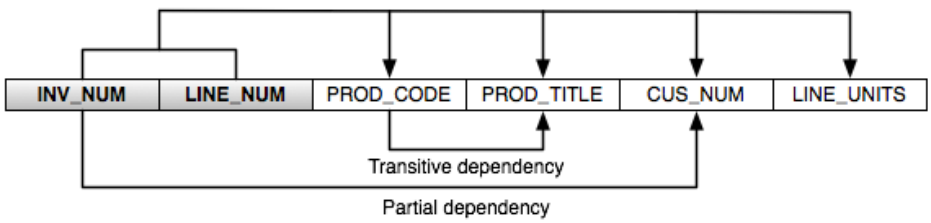

Figure 5.13: Partial & Transitive Dependency diagram

5.8.2 Multiple Choice Questions

1. Student name or student number is an example of
    (a) column or field
    (b) row or record
    (c) file or table
    (d) bit or byte
2. Maximum/Minimum Cardinality refers to the max/min number of instances of entity B that may be associated with each instance of entity A. For example assume that A is Customer, B is Form of payment, and Form of payment can take the following three values: Credit Card, check, or cash. If the company's policy is that when we enter a new customer we must record at least one form of payment, what is max cardinality of the relationship between Customer and Form of payment?

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(a) max=0
(b) max=1
(c) max=2
(d) max=3
(e) Not enough information

3. In database we have a table called tCity has the following fields: city/-town name, province, province capital, and population.

   (a) In this table the primary key should be the city/town name.
   (b) In this table the primary key should be the province name.
   (c) In this table the primary key should be the combination of city/-town and province.
   (d) In this table the primary key should be the province capital.

4. In a data base that tries to capture sales related transactions, the relationship seen from ...

   (a) the Order table to the Customer table is 1:M
   (b) the Customer table to the Order table is M:1
   (c) the Order table to the Customer table is M:1
   (d) the Customer table to the Order table is 1:1

5. A company created a database to capture sales transactions and they have included the following tables: tCustomer, tOrder, tLineItem, and tProduct. In this database they need to include a foreign key in the

   (a) table customer, so we can link it to orders
   (b) table orders, to link it to the table Line Items
   (c) table products, to link it to the table Line Items
   (d) table Line Items to link it to products

6. A company created a database to capture sales transactions and they have included the following tables: tCustomer, tOrder, tLineItem, and tProduct. In this database they need to include foreign key(s) in both

   (a) table customer and table products
   (b) table customers and table orders
   (c) tables products and line items
   (d) table orders and table line items

7. Which of the following statements is correct?

   (a) All tables must have a primary key and foreign key
   (b) All tables must have a primary key but not necessarily a foreign key

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(c) All tables must have a foreign key but not necessarily a primary key
(d) There is not enough information to evaluate these statements

8. A company created a database to capture sales transactions and they have included the following tables: tCustomer, tOrder, tLineItem, and tProduct.
   (a) In this database the table line items does not need and does not have a primary key.
   (b) In this database the table line items does not have a primary key.
   (c) In this database the table line items does not need and does not have foreign key(s).
   (d) In this database the table line items does not have a foreign key(s).
   (e) In this database the table line items needs and has primary key and foreign key(s).
9. (Refers to Employee Spreadsheet - Figure 5.14) Which of the following statements captures the relationships among departments, supervisors, employees, and jobs in the provided data set?
   (a) one regional supervisor is assigned to one employee
   (b) one job is assigned to one employee
   (c) one employee is assigned to multiple departments
   (d) there is not enough information to answer this question
   (e) one employee is assigned to multiple jobs
10. (Refers to Employee Spreadsheet - Figure 5.14) A suggestion on how to design the database for this data set included the following 3 tables: Office, Employee, and Jobs. In this database, the relationship between employees and jobs is
   (a) one-to-many
   (b) many-to-one
   (c) many-to-many
   (d) one-to-one

5.8.3 A db for Grand River Trucking Company

Grand River Trucking Company (GRT Company) is a commercial freight carrier located in Waterloo, ON. They haul truckload shipments from the customer's site to its destination. They cover all Canadian provinces. GRT

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Regional Office	Regional Supervisor	Extension	Salary	Employee ID	Employee Name	Employee Extension	JobName	Job Description	Hourly Rate
15	Zeus	2-1234	$65,000	2346	Gates	2-2345	DBA	Data Base Administrator	$28
43	Homer	2-1235	$72,000	1235	Bravo	2-2346	SAL	Sales	$15
43	Homer	2-1235	$72,000	1236	Charlie	2-2347	SAL	Sales	$23
79	Irving	2-1236	$59,000	8798	Jobes	2-2348	SYA	Systems Analyst	$30
79	Irving	2-1236	$59,000	8798	Jobes	2-2348	DEV	Developer	$25
79	Irving	2-1236	$59,000	8797	Jones	2-2349	MAI	Maint	$10
79	Irving	2-1236	$59,000	8799	Mores	2-2350	DBA	Data Base Administrator	$23
15	Zeus	2-1234	$65,000	2345	Smith	2-2351	ACC	Accounting	$21
43	Homer	2-1235	$72,000	1234	Alpha	2-2352	ACC	Accounting	$17
43	Homer	2-1235	$72,000	1234	Alpha	2-2352	SAL	Sales	$24
43	Homer	2-1235	$72,000	6548	Joslin	2-2353	SAL	Sales	$23
43	Homer	2-1235	$72,000	6548	Joslin	2-2353	ADM	Admin	$10
43	Homer	2-1235	$72,000	9087	Mills	2-2355	ACC	Accounting	$20
43	Homer	2-1235	$72,000	9087	Mills	2-2355	SAL	Sales	$28

Figure 5.14: Employee Spreadsheet

maintains a fleet of 33 vehicles and does their own maintenance work. Professional drivers are hired and paid by the hour.

Customers ask for quotes or place orders through the order department. At the time of quote/order the information collected includes the pickup time desired by the customer, pickup address, delivery time requested, delivery address, size of the load in cubic feet and weight of the load in pounds. Each order incurs charges. There are 45 different categories of charges that range from fuel, tolls, and overtime to special handling charges. Based on this information a price is quoted. If the customer accepts the quote, then a day or two before the order is executed a vehicle and driver is assigned to the order.

The company keeps careful records for each vehicle. This includes the manufacturer, capacity in cubic feet, gross weight, date purchased. In addition maintenance records are kept for these vehicles. Maintenance data includes the vehicle identification number (VIN), maintenance category, and maintenance charge. There are about 234 maintenance categories.

Records must also be kept on drivers. Information includes the name, address, telephone numbers, and commercial driver's license number. Violations require careful documentation. This documentation includes the date of violation, violation description, and fine paid. There are 27 different violation categories.

Design a data model – perform the normalization analysis of each table.

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5.9 Business Analytics Practice Problems

SQL: For identifying the best customers

While reviewing the case of Harrah's, we have seen that one of the first major take aways from the development of the common database, was their ability to identify the most valuable customers. The objective of this exercise will be to generate a series of `SQL` queries to identify the most valuable customers for the BlueBikes company. The data sets needed for this exercise will become available from the course's website.

SQL: For fraud detection

The objective of this exercise will be to generate a series of `SQL` queries to identify fraudulent transactions. The data sets needed for this exercise will become available from the course's website.

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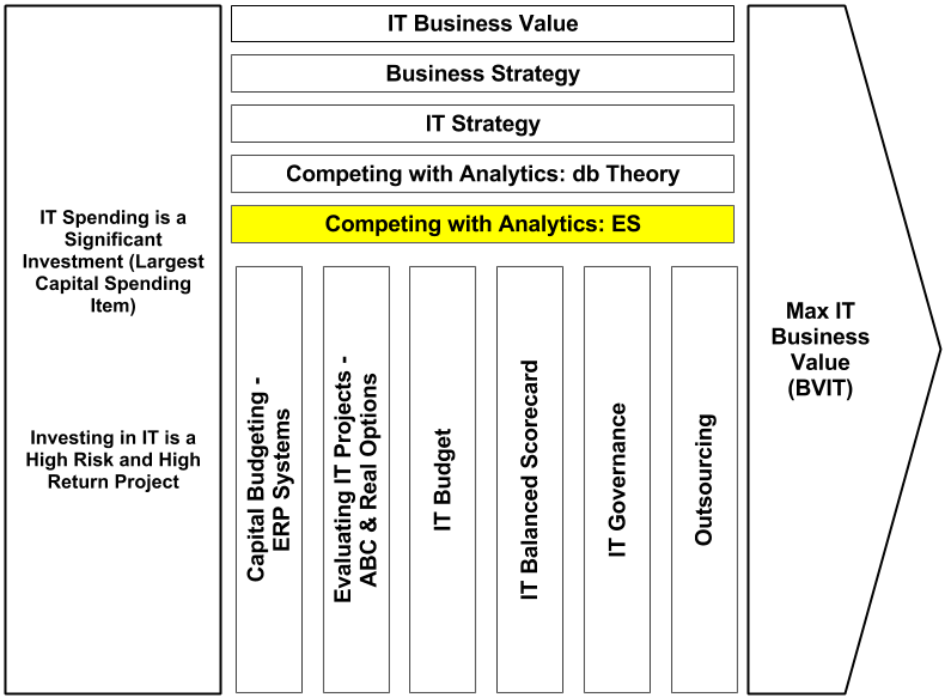
Chapter 6

Enterprise Systems

Between Scylla and Charybdis



Theophanis C. Stratopoulos, University of Waterloo

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Learning Objectives

By the end of this chapter you should be able to understand and apply the following concepts:

- Describe an ES
- Rationale for ES adoption
- Cost of ES adoption and support
- ES implementation - critical success factors
- ES expected benefits
- Understand the business process of small company
- Cloud based ES (an example)
- Order-to-Cash and Purchase-to-Pay with ES

6.1 Introduction

In Chapter 2, we looked at the firm's value chain, and concluded that while organizations are usually divided into functional units (e.g., finance, marketing), their success rests on their ability to manage complete processes. For example, when Lockheed Martin prepares a bid for a new defense contract, the process is usually conducted under time pressure and requires tight coordination across different organizational units. The preparation of such a bid involves finance, HR, and production departments. Each one of these departments may function impeccably on its own, however the processes may be impaired due to a lack of coordination among the different units. This lack of coordination, may be an indication of a badly designed process or the result of an organization which is divided into functional silos. If each department operates as an island (silo), this will slow down the processing, and lead to late submission of the bid or to an inadequately organized bid, reducing the chances of winning the tender.

In this chapter we are going to look at ES. An ES, when successfully implemented links all primary and support activities within a firm (i.e., manufacturing, logistics, sales, procurement, finance, human resources, etc.) into a comprehensive and integrated system that is based on a shared database. An ES works as the conduit that connects all primary and support activities within the firm (i.e., the company' value chain) and can integrate the company's supply chain.

An investment in an ES is the largest investment, and most demanding and complex IS implementation that the firm will undertake. *On average total implementation costs are in the range of 2-3% of revenues and consulting*

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fees can be 3 to 10 times the cost of the software. An ES system implementation will impact a very large number of employees and large number of departments within the firm.

The expected benefits typically include reduction in working capital and access to more accurate information faster about suppliers, customers, and employees. Firms that can leverage this information to support their business strategy are bound to reap significant benefits from their investment. However, as the headlines of a recent article indicate "Half of ERP projects achieve less than half of projected benefits' [125], and these expected benefits are far from certain. In some cases the results can be catastrophic. The 1996 bungled ERP implementation of FoxMeyer contributed to the firm's bankruptcy.

In this chapter, we are going to take a close look at issues related to ES implementation, famous ES failures, and some of the key success factors for ES implementation (section 6.2). We will look at the potential benefits associated with ERP system adoption and use in section 6.3, and market valuation of ES adoption related announcements in section 6.4. The last few years thanks to cloud computing ES have become more affordable and available to small companies.

As a companion to this chapter you should consider the material "ERP Definition and Solutions" prepared by Wailgum [165] for CIO.com. The material can be accessed from the following URL: http://www.cio.com/article/40323/ERP_Definition_and_Solutions#erp

6.2 ES Implementation

6.2.1 Famous ES Implementation Failures

The business and technology press is littered with stories of executives and firms that have experienced a dramatic failure during their ERP implementation. The following stories provide some more detail and highlight some of the most spectacular failures.

Overstock.com's Four-Year ERP Nightmare

Overstock.com, the upstart unafraid to battle e-commerce Goliath Amazon, has become semi-famous because of its brash and highly quotable leader, CEO Patrick Byrne, who once explained a $14.2 million third-quarter loss to investors this way: "My bad." The online retailer has also drawn notice for its

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gimmicky advertising campaigns: "The Big O" and "It's all about the O."[1]

The latest publicity for Overstock.com, however, has been all about "Uh-oh." This week, Overstock.com executives announced they were restating earnings for a five-and-a-half-year period, dating back to 2003. All told, the accounting mistakes during the period had lead to a $12.9 million reduction in revenue and a $10.3 million increase to cumulative net loss. The culprits behind all this mess?

An overly aggressive CEO and a problematic Oracle ERP roll out that started back in 2005. I'll spare you the financial accounting reasons for the restatement, and let a sampling of Byrne's explanation to shareholders sum it up: "The short version is: when we upgraded our system, we didn't hook up some of the accounting wiring; however, we thought we had manual fixes in place," he wrote. "We've since found that these manual fixes missed a few of the unhooked wires."

Figure 6.1: Overstock Logo

Looking back through Overstock.com's short history, it appears that the ERP implementation has been nothing but trouble. The strife started in 2005. That's when Byrne's "my bad" mea culpa over the $14.2 million loss was further exacerbated by a customer service meltdown related to the hurried Oracle ERP roll out "I bit off more technology projects than my colleagues could chew," Byrne told investors at the time. "The last bite, an ERP implementation, was one bite too many, and we choked on it."

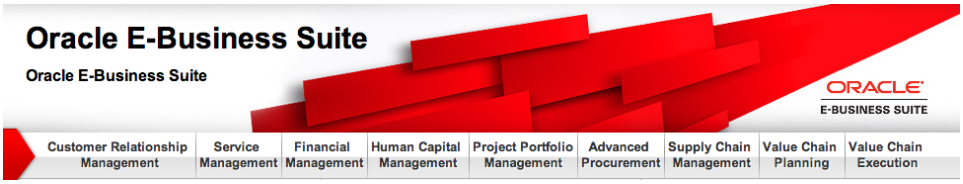

Figure 6.2: Oracle eBusiness Solutions

[1]Source: Wailgum [164]

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Overstock's transition from a homegrown ERP package to the new Oracle system (See Figure 6.2), which was rushed to completion before the 2005 holiday shopping season, left it unable to tell customers the status of their orders or to provide any shipping information, reported The Register's Ashlee Vance in late October 2005. The result: Overstock.com's customer tracking systems were down for nearly a week. "In total," Vance added, "it's a shocking display for a supposed Internet-savvy retailer meant to compete with the likes of Amazon.com and eBay." Byrne, in the 2005 note to shareholders, remained resolute. "We anticipated that a small number of background processes would fail, but we had more trouble than expected," Byrne wrote. "Rather than pass the problem to the customer in the form of bad service, we ate the cost by doing a great many things manually that would normally be done automatically."

Things didn't get any better in 2006. In November, in another letter to investors, Byrne wrote "The IT problem that developed last September...has had lingering effects that ran well into this year," reported The Register's Vance. "In fact, while we viewed it internally as a 2005 Q4 to early 2006 Q1 problem (which is what it was technologically), I see now that, in terms of affecting customer behavior, it was more of a 2005 December to 2006 April problem. It has taken an enormous amount of work to recover," Byrne added, "but our operations and infrastructure are now healthy and strong." Vance, who had had a bad customer experience with Overstock.com during 2005, went on to point out in 2006 that "after denying evidence to the contrary, Overstock has admitted that its customer service systems and infrastructure needed a lot of work and that they had a negative, long-term impact on consumers."

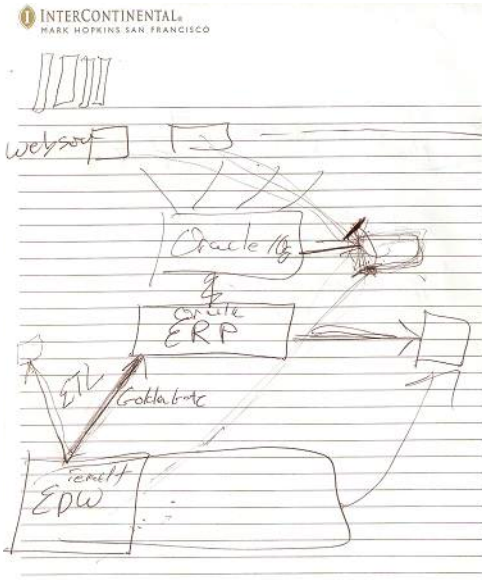

Figure 6.3: A CEO's view of an ES

In August 2007, Byrne and Vance had a sit down (apparently their CEO-reporter relationship had been tense), and Byrne cleared the air about the ERP meltdown and customer service nightmare, accepting full responsibility

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for installing the Oracle ERP software in "record time." Byrne told Vance: "It was really my fault. I had us wait too long to upgrade the IT system and then pushed too hard to get a new one rolled out." Problems with the rush job manifested itself in strange ways. "Some things were going through okay and a lot weren't," Byrne said. "It was just spraying orders. Sometimes customers might not get a ship confirm. Sometimes the order might not flow through the system. Sometimes the order got misrouted." Byrne even sketched a picture of Overstock's ERP system for Vance (See Figure 6.3). By late 2007, Overstock.com's technology odyssey seemed like yesterday's news.

But then, in October 2008, we learned about the mother of all ERP-related problems: Overstock.com had to restate earnings because of the Oracle ERP system. For the record, Overstock.com placed all the blame on themselves (they're getting quite good at that, it seems). "Honestly, it didn't have anything to do with Oracle per se, it was the implementation," said Kevin Moon, Overstock.com's director of investor relations. "We had consultants and we had help, but it was all driven by Overstock. We set the timelines." Will Overstock.com recover? After the restatement and delivery of the third-quarter financials, The Motley Fool financial website named it as one of five stocks in a tailspin (though Overstock would seem to have a great deal of company these days). Byrne seems unchanged. ...

Definitely Not a Sweet Experience for Hershey

Could a failed technology implementation (in this case SAP's R/3 ERP software) take down a Fortune 500 company (in this case Hershey Foods)? Well, it certainly didn't help Hershey's operations during the Halloween season in 1999 or make Wall Street investors thrilled. In the end, Hershey's ghastly problems with its SAP ERP, Siebel CRM and Manugistics supply chain applications prevented it from delivering $100 million worth of Kisses for Halloween that year and caused the stock to dip 8 percent. So I guess a failed technology project can't actually take down a Fortune 500 company for good, but it can certainly knock it around a bit.[2]

Figure 6.4: Hershey's Halloween Add

[2]Source: Wailgum [164]

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Just Do It: Fix Our Supply Chain System!

What did a $400 million upgrade to Nike's supply chain and ERP systems get the world-renowned shoe- and athletic gear-maker? Well, for starters, $100 million in lost sales, a 20 percent stock dip and a collection of class-action lawsuits. This was all back in 2000, and the horrendous results were due to a bold ERP, supply chain and CRM project that aimed to upgrade the systems into one superstar system. Nike's tale is both of woe and warning.

HP's "Perfect Storm" of ERP Problems

The epic tale of HP's centralization of its disparate North American ERP systems onto one SAP system proves that one can never be too pessimistic when it comes to ERP project management. You see, in 2004, HP's project managers knew all of the things that could go wrong with their ERP roll out But they just didn't plan for so many of them to happen at once. The project eventually cost HP $160 million in order backlogs and lost revenue - more than five times the project's estimated cost. Said Gilles Bouchard, then-CIO of HP's global operations: "We had a series of small problems, none of which individually would have been too much to handle. But together they created the perfect storm."

The SideNote: SAP & Oracle provides a brief introduction of the two major companies producing ES. Both of these companies are referenced in implementation failures.

SideNote: SAP & Oracle (Wikipedia)

SAP AG is a German multinational software corporation that makes enterprise software to manage business operations and customer relations. Headquartered in Walldorf, Baden-Württemberg, Germany, with regional offices around the world, SAP is the leader in the market of enterprise applications in terms of soft-

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ware and software-related service. The company's best-known software products are its enterprise resource planning application systems and management (SAP ERP), its enterprise data warehouse product – SAP Business Warehouse (SAP BW), SAP BusinessObjects software, and most recently, Sybase mobile products and in-memory computing appliance SAP HANA. SAP is one of the largest software companies in the world.

Oracle is an American multinational computer technology corporation headquartered in Redwood City, California, United States. The company specializes in developing and marketing computer hardware systems and enterprise software products – particularly its own brands of database management systems. Oracle is the third-largest software maker by revenue, after Microsoft and IBM. The company also builds tools for database development and systems of middle-tier software, enterprise resource planning software (ERP), customer relationship management software (CRM) and supply chain management (SCM) software.

6.2.2 ES Implementation - Rationale and Scope

In order to understand why so many firms fail to implement their ES successfully, we need to start with the rationale and scope of ES implementation.

The rationale for implementation varies among companies and reflects their specific needs as well as industry and economic conditions. While the main reason for most companies is the need for a common and integrated IT platform, other reasons include the opportunity to improve business processes, increase data visibility, reduce operating cost, increase responsiveness to customers, and improve the firm's strategic decision-making.

The kind of justification that a firm uses is likely to affect the physical scope, business process scope, technical scope, module implementation strategy, and resource allocation of an ERP implementation.[3] In the following paragraphs we will examine each one of these implementation scopes and consider its implications.

The **physical scope** of an ES implementation determines whether the implementation will cover one or multiple sites within one geographic region

[3]The following discussion is based on Parr and Shanks [118].

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versus multiple sites scattered across many different national or international regions. For example, in the case of Whirlpool Europe (Ruback et al. 2001) the implementation encompassed several different divisions across Europe. The SideNote: Justification and Scope provides another example of ES implementation in a multinational oil company.

In general there a positive correlation between the physical scope of an ES implementation and such attributes as number of users involved as well as the number of regional offices that will have to implement. As the physical scope of the project is increasing, the complexity, cost, and implementation time are rising.

SideNote: Justification and Scope

"... In a multinational oil company the justification for implementing a multi-site ERP system was driven by a long history of disconnection between global IT vision/strategy and regional IT practices. While the parent company always wanted one integrated and comprehensive IT system that could tie together the systems across national boundaries, local business units had developed their own systems and were reluctant to change. Each local unit had adopted its own variation of business practice. When the parent company saw an opportunity for a multinational integrated system, they viewed this as a resolution of the disjunction between policy and practice."[a]

Q: What is the justification and scope of this ERP implementation?

[a] 118.

ES implementations tend to be associated with an opportunity or the challenge of whether to re-engineer the firm's business processes, i.e., **business process re-engineering (BPR) scope**. (The SideNote: Business process re-engineering provides a brief introduction to this management concept). For these firms BPR is the first step during which the firm changes its business processes. The firm maps its business processes onto the ES. This approach is called 'Vanilla' implementation. On the other hand, a firm may choose to keep its own business processes and customize the ES software to match the firm's business processes.

SideNote: Business process re-engineering

The term business process re-engineering (BPR) was introduced in 1990 by Michael Hammer in a Harvard Business Review, in which he

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claimed that the major challenge for managers is to obliterate forms of work that do not add value, rather than using technology for automating it. The main premise of BPR is that management should focus on the analysis and design of work flows and processes within an organization. Managers need to rethink how they do their work. The need to redesign processes in order to improve customer service, reduce operational costs, and become more competitive. In the mid-1990s, BPR became a management fad. Reports from this period indicate that about 60% of the Fortune 500 companies were either planning to or had started BPR initiatives.

Among others, the team responsible with the ES implementation needs to compare its own business processes with the 'best practice' process that is used in the chosen software.The challenge is to decide which processes will be adopted as they are in the software (vanilla implementation), and which are to be customized (customization of ES to meet the firm's business needs). The firm's BPR related choice is intertwined with the **technical scope** of ES implementation. The firm's management must decide how much the ES software is to be modified. In general ES customization tends to lead to an exponential increase in complexity, cost, and length of ES implementation.

The typical ES has several modules such as inventory management, plant maintenance, production, project management, sales and distribution, forecasting, asset management, human resources, and financial. Each module has several sub-modules. For example the finance module includes the general ledger, accounts receivable, accounts payable, etc. It is highly unlikely that a firm will implement all these modules. Therefore, from a module implementation standpoint a firm must decide which modules and sub-modules to select (i.e., **functional scope**). Figure 6.5 provides a quick view of modules available in the SAP business suite. As we have seen in Figure 6.2, Oracle's eBusiness solution provides similar modules.

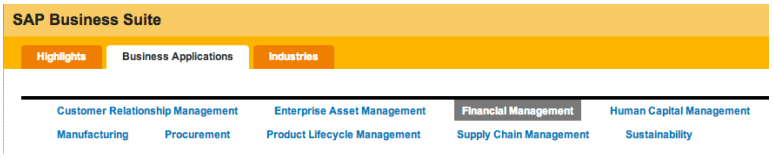

Figure 6.5: SAP Business Suite

Another very important choice that the implementation team will have to consider is how to connect each module to the existing systems. In general firms tend to chose from the following three options.

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The first one is known as the **phased roll-out** or **cascaded roll-out** and the change occurs in phases over an extended period of time. The implementation is module-by-module, and as each module is implemented it is connected to the existing system. Phased roll out may also refer to the site by site implementation of ES.

The second approach is called **big bang** and implementation happens at the same time. All modules are implemented and connected to existing systems simultaneously. This means that all user and all sites move the new system on a given date. This is much riskier but less time consuming. Figure 6.6 provides a graphical representation of the trade off between implementation risk and time to implement for the two implementation options (phased versus big bang).

The third approach is called **parallel adoption**. This means that for a while a firm is running two systems the old (legacy system) and the new ES. Users can learn how to use the new system while working on the old system. Running two systems has its pros and cons. If there are any problems with the new system users can identify them and developers can fix them before the system goes live. The firm does not have to experience any disruptions in its operations due to problems of the new system. On the other hand this is can be very expensive.

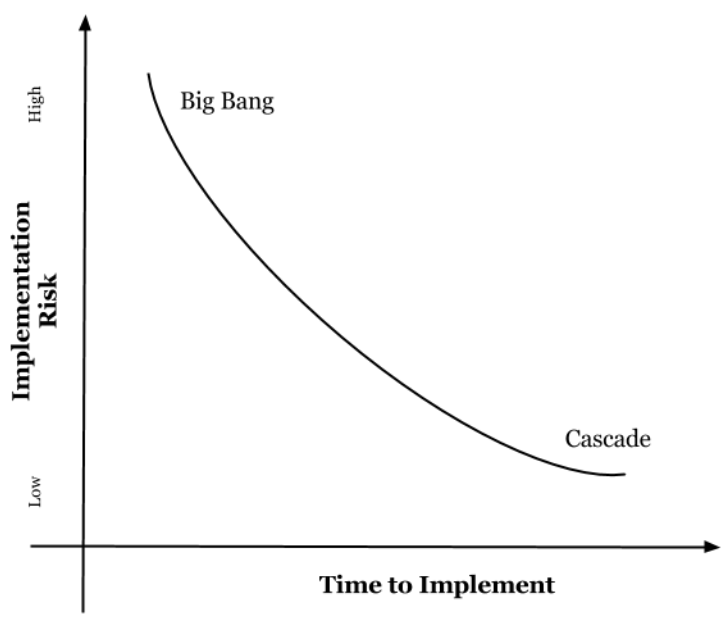

Figure 6.6: Risk versus Time trade off in implementation

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Finally, the **resource allocation scope** of an ES implementation will depend on all other scope related choices. An ES implementation may last from a few months to several years and it can cost from hundreds of thousand to hundreds of million of dollars.

The successful and unsuccessful stories that we have seen in this chapter point to constant trade-off and multitude of choices that firms have to make when it comes to ES implementation. In most of these cases the trade-offs indicate that the firm's management will have to make some tough choices. In order to appreciate the trade-off you will have to consider the the pros and cons of vanilla versus customization choice from a strategic standpoint. You will have to consider the implications of vanilla versus customization choice from a financial standpoint. You will have to evaluate the pros and cons of mixing modules and sub-modules which have been purchased from different vendors from a strategic, financial, and operational standpoint. Like the modern Odysseus, managers will have to pick the lesser of two evils (see SideNote: Scylla and Charybdis).

SideNote: Scylla and Charybdis

Scylla and Charybdis were mythical sea monsters noted by Homer; later Greek tradition sited them on opposite sides of the Strait of Messina between Sicily and the Italian mainland. Scylla was rationalized as a rock shoal (described as a six-headed sea monster) on the Italian side of the strait and Charybdis was a whirlpool off the coast of Sicily. They were regarded as a sea hazard located close enough to each other that they posed an inescapable threat to passing sailors; avoiding Charybdis meant passing too close to Scylla and vice versa. According to Homer, Odysseus was forced to choose which monster to confront while passing through the strait; he opted to pass by Scylla and lose only a few sailors, rather than risk the loss of his entire ship in the whirlpool.[a]

[a] Source: Wikipedia

6.2.3 ES: Critical Success Factors

The story of Overstock, Hershey's, Nike, HP and many others indicate that implementation of ES is a risky undertaking. The failure rate is very high and the financial costs tend to be substantial. This has prompted the need to

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try to understand what factors contribute to the successful implementation and adoption of ES. Numerous academic studies and professional reports have focused on factors that contribute to the successful implementation of an ES project. In the following paragraphs we will try to organize these findings by approaching them from an internal (management and users) as well as an external standpoint (consultants).[4]

Not surprisingly and consistent with the findings of the Chaos report (pp. 95-**??**), on top of the list of critical success factors (CSF) is the role of **top management support**. The argument is that the top management team (TMT) will set the tone at the top, and this tone will trickle down to the rest of the company. If the TMT sends the message that the ES adoption is a high priority, lower level managers and users are more likely to try harder to succeed, simply because they know that this matters to the firm's TMT. In addition to this it is well documented that supervisees will try to emulate the behavior of their supervisors. If the successful implementation of ES is a priority for senior executives it will become a priority for the people reporting to them too.

While the top management support is important from a psychological standpoint, it should also provide a high level guidance regarding the firms objectives. It is the responsibility of the top management team to convince all members involved with the ES adoption that this initiative is aligned with the firm's business strategy. To maximize the cooperation of all key players, firms will tend to establish a **steering committee**. Typically this committee is comprised of senior management from different corporate functions and end-users. Members of the committee tend to be involved in ES selection, they monitor ES implementation, and oversee outside consultants. The composition of the committee should represent all different expertise associated with ES adoption. That is the committee should have members who understand the firm's strategy, operations, finances, as well as ES related technology.

The need to have a project champion is considered another relatively important CSF. The individual should possess strong leadership skills, as well as business, technical and personal managerial competencies.

The team responsible with ES adoption should be able to provide the appropriate **visioning and planning**. More specifically it has been observed that the probability of successful ES implementation increases when the following conditions are met: 1) The team has developed specific and

[4]The following discussion is based on Finney and Corbett [42]

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measurable objectives.[5] 2) There is a plan as well as a contingency plan on how to respond to potential mishaps. 3) The plan has incorporated some degree of risk. 4) There is a clear articulation of the tasks that will have to be completed at each stage. This involves allocating of responsibilities to various players, the definition of milestones and critical paths, training and human resource planning. 5) Implementation progress is benchmarked versus internal and external best practices.

The composition of the implementation team should cover the organization and provide a balance of business and IT skills. It has been a recurring theme in several studies that the core implementation team should be comprised of the organization's best and brightest employees. These individuals should have a proven reputation and there should be a commitment to "release" these individuals to the project on a full-time basis. The members of the team should be empowered with the appropriate power to make necessary decisions in due time.

There are several areas of concern, which if properly addressed will increase the likelihood of a successful implementation and adoption. First, there is the need for the implementation team to prepare a plan on how to deal with **change management**. This means to consider the implications of ES adoption for management and users. The top priority from a change management standpoint is to build user acceptance of the project and a positive employee attitude. Firms can accomplish this through a two pronged education program that aims to educate users on the benefits of ES, as well as the need for an ES.

Managing cultural change is the second area of concern. The implementation team must be aware of cultural differences and preferences from both organizational as well as from a geographical perspective. Adoption of best practices that were developed based on firms from Europe or North America may not be aligned with cultural norms in South East Asia. The team must try to minimize the adoption cost for all stakeholders.

By its very nature the implementation and adoption of an ES will be associated and will require high level of communications among various functions/levels. Thus **communication plan** is the third area of concern. The implementation team must have in place a plan to ensure proper line of communication, particularly between business and IT personnel, as well as with suppliers and customers.

The fourth area of concern is that of **team morale and motivation**

[5] In Chapter 8 we will look at the creation of a balanced score card for ERP implementation as a way to measure and monitor the progress of an ERP implementation.

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and by extension **employee retention**. The ES implementation is likely to be a stressful as well as rewarding experience for the employees involved. The project manager needs to nurture and maintain a high level of employee morale and motivation during the project. This should manifest in high level of staff retention. Many companies experienced a serious risk of an ES implementation failure when they lose key players. Employees with good ES implementation management skills tend to be very marketable.

Choosing the right **consultant** is only half of the fifth concern that the implementation team needs to consider. The other half is that of a well defined plan of **knowledge transfer** from the consultant to the company so as to decrease the dependency on the vendor/consultant. This goes hand-in-hand with the sixth area of concern which is that of **training and job redesign**. Typically the should encompass the development of IT skills and that it should be hands-on. Management needs to take into account how staff may need to be restructured, or how compensation plans may need to be evaluated and modified.

The final area of consideration and concern is that of **data conversion and integrity**. The bottom line remains that the success of the implementation process and ultimately the success of the system relies on the ability of the team to ensure data accuracy during the conversion process.

SideNote: Project cost planning and management

... It is important to know up front exactly what the implementation costs will be and dedicate the necessary monies. However, the nature of ERP implementations are such that there are usually unforeseen and unexpected occurrences that increase the overall costs. Therefore, a loose budget policy is recommended.[a]

Q: Do you agree with the above recommendation about the 'loose budget policy'? How is the company's business and IT strategy going to influence your view regarding this suggestion? How is this related to the BPR choices that the firm is considering?

[a] 42.

6.3 Expected ES Benefits

Like the ES themselves, the expected benefits associated with ES adoption span the entire organization. In the following sections, we will try to organize

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these benefits. We will explore expected ES benefits for different levels of management in section 6.3.1. We will try to understand accounting benefits in section 6.3.2. We will look at benefits related to the firms IT infrastructure in section 6.3.3, and close with benefits/implications for competing with business analytics in section 6.3.4.

6.3.1 Benefits: Management Standpoint

At the organizational level ES adoption has been used to help build integrated processes, improve employee communication, foster the development of a 'common vision' and user empowerment, support customer services and facilitate a flattening of organizational structure. Given the fact that the ES adoption is likely to affect the majority of users in an organization, it makes sense to organize the ES benefits according to different stakeholders. The most commonly used classification is the one that looks at the organizational 'pyramid' and classifies benefits from an operational, managerial or tactical, and strategic standpoint. In the following paragraphs we are going to explore expected benefits from a stakeholder standpoint.[6]

The vast majority of firms have a hierarchical structure in which every entity in the organization, except one (the CEO), is subordinate and reports to a single other entity. The most common visualization of such a hierarchical structure is a pyramid shown in Figure 6.7.

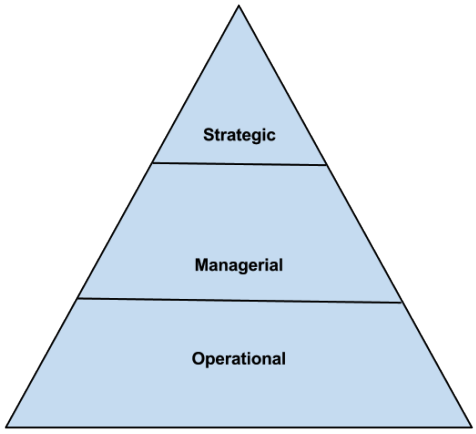

Figure 6.7: Organizational Pyramid

Each layer in this pyramid represents a different level of management and responsibilities. The lower one is the widest and reflects the operational level of the firm. The second one is the managerial and it is responsible with execution of the firm's strategy. The highest is the strategic one and it is responsible for the development of the firm's strategy.

At the **operational level**, managers are responsible with the supervision of activities that involve the acquisition and consumption of resources.

[6]Section 6.3.1 is based on the findings of Shang and Seddon [137].

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These type of activities tend to be repetitive and with a short period. The most common scenario is that activities will be repeated daily, weekly and monthly. The impact of ES adoption on operational level tends to be with its role as a source of automation. As we have seen in Chapter 3 (see p. 81), IT investments can be used to streamline processes and automate transactions, speed up processes, substitute labor, and in the process increase operation volumes. Therefore, an ES that can automate business processes and enable process changes at the operational level could deliver the following expected benefits:

1. cost reduction
2. cycle time reduction
3. productivity improvement
4. quality improvement
5. improved customer service

At the **managerial or tactical level**, managers are responsible with activities that involve allocation and control of the firm's resources, monitoring of operations, and supporting of business strategic decisions. In order to fulfill these tasks managers need to rely on summary and exception reports. This means that they need to aggregate information that has been produced at the operational level in order to evaluate the effectiveness and efficiency of current operations, and evaluate the effectiveness of choices regarding allocation of resources. They rely on ES to help them disseminate information down the operational level, and receive information from the operational level. Recall that in Chapter 3 we have called the former as informate down (p. 82) and the latter informate up (p. 82). Similarly, they need to provide aggregate information to the firm's top management team and receive information from them. ES with their centralized databases and built-in data analysis and reporting capabilities, are ideally placed to provide real time reports both up and down the organizational ladder. Therefore, it is expected that ES could deliver the following benefits at the managerial level:

1. better resource management
2. improved decision making and planning
3. improved performance in different operating divisions of the organization

At the **strategic level** focus shifts to the firm's relative (i.e., competitive) performance. Senior executives are interested in knowing to what extent adoption of ES can contribute to a firm's ability to enjoy an IT enables

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competitive advantage (i.e., offensive role of ES adoption), help the firm maintain its current competitive position (i.e., defensive role of ES adoption), or support the firm's corporate strategy (e.g., role of ES in support the firm's mergers and acquisitions). ES can play an important role in any of these dimensions. For example, firms can leverage ES adoption to achieve competitive differentiation by customizing products or services for individual users and achieve this at a lower cost. Firms have leveraged ES to support tight links with trading partners and achieve higher level internal/external integration capabilities. Therefore, it is expected that ES could deliver the following benefits at the strategic level:

1. business growth
2. alliance
3. innovation
4. cost
5. differentiation
6. external linkages

6.3.2 Benefits: Accounting Standpoint

Accounting information systems (AIS) offer managers transaction processing services, reporting and information to support decision-making.[7] As such AIS provide accounting information to both internal and external users. Given that automation, effectiveness, efficiency, and need for real time data are important factors for business success in the modern competitive environment, it is natural that at the heart of any ES is an accounting module. The typical accounting module contains several submodules for general ledger, accounts receivable/payable, the fixed asset register, cash management, cost control and budgeting.

Historically, accounting module is one of the first ES modules that firms tend to implement. From an accounting standpoint, the motivation for the adoption of ES is driven by the following expected benefits:

1. increased flexibility in information generation
2. increased integration of applications
3. improved quality of reports
4. reduction of time for issuing of reports
5. improved decisions based on timely and reliable accounting information

[7] Section 6.3.2 is based on the findings of Spathis [146].

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6.3.3 Benefits: For IT Infrastructure

IT infrastructure consists of all sharable and reusable IT resources.[8] It provides a foundation for present and future business applications. Typical examples of IT infrastructure are telecommunications networks and servers. Companies devote a substantial portion of their IT budgets on IT infrastructure. Technically, ES are not clearly identifiable as IT infrastructure, nevertheless they represent a significant investment of a firm's resources. ES form a foundation on which firms build numerous business applications. ES provide an infrastructure that supports:

1. business flexibility for future changes
2. reduced IT costs and marginal costs of business units' IT
3. increased capability for prompt and economic implementation of new applications

6.3.4 Benefits: For Competing with Business Analytics

Perhaps one of the best examples, regarding the role of ES as a foundation for development of future applications, is that of decision support systems (DSS) and business intelligence (BI) systems. In other words, ES adoption is the foundation for a firm's ability to compete in terms of business analytics.

While from a functional standpoint ES are different from DSS and BI systems, it is relatively easy to see why ES is the foundation for both of these systems. As we have seen the ES are transaction focused. They are designed to capture the flow of information associated with the firm's business processes. Given that behind the typical ES is a database with thousands of tables, it is quite natural that the ES will accumulate a vast amount of transaction level data. The typical ES provides the user with the tools to summarize these data and prepare reports that can used to monitor performance and support decision making.

Firms that want to leverage these data in order to compete in terms of business analytics will have to do the following: First, they will need to extract the transactional data and transfer them into a data warehouse. Second, they will have to invest in the appropriate DSS and BI tools. Users with the appropriate data analytics skills will analyze these data in search for patterns that can be used to support the firms quest to compete in terms of business analytics. Therefore, in order to realize the full benefits of centralized information and use of integrated systems, ES are also often augmented with DSS, BI, and other analytics applications.

[8] Section 6.3.3 is based on the findings of Shang and Seddon [137]).

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6.4 Business Value: Accounting/Finance Angle

If you were an investor and you read in the news that firm XYZ has just announced an investment in Enterprise System how would you react? Would you think that the company would be worth more or less? What additional information would you want to know in order to finalize your decision?[9]

ES were designed to link distinct and interdependent business units, thus provide technological and business integration. Technological integration means that the firm instead of having many isolated information systems based on customized applications, can have a common IT infrastructure that allows smooth transfer of information from one business unit to another. From a purely technical standpoint, data entered by the company's salespeople can be accessed by the accounting department because all data resides in one common database. If this technical integration is coupled with appropriate investments in human skills, new work flow, or process redesign, it can lead to business process integration.

In addition to this the announcement of an ES implementation indicates that the firm is 'buying an option' that can be used to support future investments in e-commerce and supply chain management. ES is an option in the sense that ES is the foundation for the development of e-commerce and supply chain application. Having this foundation allows the firm to exercise its growth option of developing an e-commerce or supply chain solution. Technological and business integration as well as the growth options are some of the possible consideration that an investor may consider in order to establish the effect of ES adoption or purchase decision on firm value.

A bit of deductive reasoning will help you understand the additional information that an investor may find useful in order to evaluate an ES implementation announcement. Given that all prior discussion revolved around integration, what theory have we seen that relates to this concept? The answer is Porter's value chain. As we have seen in Chapter 2, a firm's activities can be divided in primary and support. A firm's ability to integrate these activities better than its competitors is what makes a company more valuable than its competitors. Obviously an ES announcement that indicates that the firm will invest in just the Material Resource Planning (MRP) or human resource management module is useful but it does not increase the firm's ability to integrate its value chain or may not increase its growth option. On the other hand, an announcement indicating that the firm will implement an entire ES suite signals that the firm will try to integrate the

[9] This was the theme of a study by Ranganathan and Brown [127]).

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entire value chain. The second type of announcement implies that the firm is maximizing its growth option. The firm is ready to integrate its value chain, if the right opportunity arises, with customer, suppliers, or any other potential partner.

Therefore, what the investor may want to know is the firm's decision regarding the number of modules that the firm will implement. Recall that this has been defined as functional scope of ES implementation (see p. 178). Consistent with Porter's value chain and with RBV (Why?) the higher the functional scope the greater the expected increase in firm value. A similar argument can be made regarding the firm's decision to implement in one one or more geographic location, in one or more countries (physical scope).

Ranganathan and Brown [127] analyzed 116 ES implementation announcements from the period 1997 to 2001. They measured the market value effect of these announcements by comparing the actual value of the firm's stock price versus what the could have been the expected stock price given how the market moved. The study found that functional and physical scope have a positive impact on market valuation. *"... The 41 ERP projects with both greater functional scope and greater physical scope resulted in increased abnormal returns of 3.29%. That is, investors responded even more favorably to those ERP projects that had the greatest organizational integration potential - i.e., projects that included two or more value-chain modules that would be deployed at multiple locations."*

6.5 Summary and Concluding Remarks

ES adoption is one of the most challenging IT investments that a firm will undertake. Like modern Odysseus, managers have to navigate between the Charybdis of not investing in ES and fall behind the rest of the industry and the Scylla of having to deal with the so many risks associated with ES implementation. Whether ES is seen as a mandatory investment that a firm has to make to keep up-to-date with the new technologies in order to remain competitive or a new opportunity that the firm leverage to improve its competitive position the risks are high. Like Odysseus all large firms and by now most of the small firms have chosen to go with ES implementation and some of them have been more successful than others.

As a final reminder of the sheer magnitude of this project consider the following excerpt from the the material "ERP Definition and Solutions" prepared by Wailgum [165]: **What does ERP really cost?**

One of the most often-cited studies of the total cost of ownership (TCO)

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of ERP was completed by Meta Group in 2002. (Gartner acquired Meta Group in 2005.) This TCO study accounted for hardware, software, professional services and internal staff costs. Costs included initial installation and the two year period that followed, which is when the real costs of maintaining, upgrading and optimizing the system for your business are felt.

Among the 63 companies surveyed-including small, medium and large companies in a range of industries-the average TCO was $15 million (the highest was $300 million and lowest was $400,000). While it's hard to draw a solid number from that kind of range of companies and ERP efforts, Meta came up with one statistic that proves that ERP is expensive no matter what kind of company is using it. The TCO for a "heads-down" user over that period was a staggering $53,320.

Results from a 2007 Aberdeen Group survey of more than 1,680 manufacturing companies of all sizes found a correlation between the size of an ERP deployment and the total costs. Therefore, "as a company grows, the number of users go up, along with the total cost of software and services," states the Aberdeen report. For example, a company with less than $50 million in revenue should expect to pay an average of $384,295 in total ERP costs, according to the survey results. A mid-market company with $50 million to $100 million in revenues can expect to pay (on average) just over a $1 million in total costs; a much bigger mid-market company, with $500 million to $1 billion in revenues, should expect to pay just over $3 million in total costs. And those companies with more than $1 billion in revenues can expect to pay, on average, nearly $6 million in total ERP.

6.6 Practice Questions and Problems

6.6.1 Study Questions

1. Find a recent story about ERP implementation.
2. Are ERP implementation related failures a past phenomenon?
3. Do your own research about cloud computing and see how it has affected the ES market
4. What are some of the key differences between operational versus tactical benefits associated with ES implementation?
5. What are the primary accounting benefits associated with ES implementation?
6. What is the functional scope of ES implementation and how does this relate to expected effect on firm value?

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7. What is the physical scope of ES implementation and how does this relate to the expected effect on firm value?

6.6.2 Multiple Choice Questions

1. Which of the following expected ERP benefits is managerial (i.e., relates to managerial level of management)?
   (a) increased capability for prompt and economic implementation of IT applications.
   (b) external linkages.
   (c) improved performance in different divisions.
   (d) improved customer service.
2. Which of the following expected ERP benefits is strategic (i.e., relates to strategic level of management)?
   (a) improved customer service.
   (b) increased capability for prompt and economic implementation of IT applications.
   (c) improved performance in different divisions.
   (d) external linkages with trading partners.
3. A company used its ERP system in order to analyze fulfillment execution and generated the following results: On time=43%; Shipping Delay=29%; Out of Stock Delay=14%; Packing Delay=14%. This report/information will be useful in order to identify ...
   (a) areas of strengths and weaknesses using Porter's Five Forces.
   (b) areas of strengths and weaknesses using Porter's Value Chain.
   (c) opportunities and threats using Porter's Five Forces.
   (d) opportunities and threats using Porter's Value Chain.
4. The organizational chart of a firm shows the following reporting structure: Mark S. and Charles M. work on the shop floor and they report to Catherine V. who is the plant manager. Catherine report to the company's president John G. The typical way to capture this structure in a database is with
   (a) a many-to-one relationship.
   (b) a many-to-many relationship.
   (c) a recursive relationship.
   (d) a one-to-many relationship
5. An ERP system was used to prepare a report showing average delay

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in delivery purchase order by vendor in the last 12 months. This is an example of using ERP to

(a) perform business analytics to support decision making.
(b) complete a transaction in the sales process.
(c) complete a transaction in the procurement process.
(d) complete a transaction in the sales and procurement process.

6. The typical procurement process will start in _____ and end with the _____.

(a) warehouse, accounting
(b) accounting, warehouse
(c) purchasing, warehouse
(d) warehouse, warehouse

7. In the procurement process, which department receives the Purchase Requisition?

(a) Sales
(b) Purchasing
(c) Warehouse
(d) Accounting

8. Two records derived from a table that captures the packing list related information contain the following information:
CustID=4302; OrderNo=29837, SalesPerson= (Blank, there is no entry in this cell)
CustID=4303; OrderNo=29838, SalesPerson= Willy Looman.
Based on these records we can conclude that the minimum and maximum cardinality from the table Orders to the table Salesforce are ...

(a) There is not enough information to establish cardinality.
(b) zero and one
(c) zero and many
(d) one and many

9. Which of the following statements regarding enterprise systems (ES) and business intelligence systems (BI) is correct?

(a) An ES is based on a transaction database while a BI is based on a data warehouse type of database.
(b) Both ES and BI are based on a transaction database.
(c) Both ES and BI are based on a data warehouse type of database.

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(d) An BI is based on a transaction database while a ES is based on a data warehouse type of database.

6.7 Business Analytics Practice Problems

6.7.1 Expected duration of ERP adoption related competitive advantage

The objective of this exercise is to assess the implicit assumptions made by WHR management regarding the expected duration of competitive advantage due to ERP adoption?

1. According to Stratopoulos [150], what is the expected duration of competitive advantage due to ERP adoption?
2. What is the assumption made by WHR management regarding the expected duration of incremental benefits associated with ERP adoption?
3. Does this assumption sound reasonable? Explain why.
4. What would happen to the NPV of the project if we were to change it?

6.7.2 Alignment of ES with Enterprise Goals

The objective of this exercise is to assess the alignment of Whirlpools ERP initiative with its strategic priorities. In order to complete this exercise you will have to leverage material from Chapters 1, 2, 3, and 6, as well as the Whirlpool case [131].

1. Make a list of key words that indicate that a firm is implementing a cost leadership or product differentiation strategy.
2. Read the the Whirlpool case [131] and record key words associated with cost leadership or product differentiation strategy.
3. Generate a simple 1×2 frequency table or a pie graph to summarize your results.
4. Using Compustat data from the period 1996 to 1998 perform the DuPont analysis of Whirlpool versus the industry (use four digit GIC).
5. Generate appropriate graphs to show the comparison of DuPont analysis between Whirlpool and the industry.
6. Compare the IT strategic goals with the business strategy/strategic priorities in order to provide an assessment and recommendation regarding the alignment of IT goals and strategic priorities.

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7. Tell the story based on your analysis.

6.7.3 Suggested Reading

The paper by Tian and Xu (MISQ 2015) has a nice discussion about the functional and operational modules of ERP systems.

... Porter and Millar (1985) categorized the processes of a firm's value chain as operational and functional processes. Operational processes are involved in the physical creation of products, logistics, and delivery to customers. Functional processes provide a common infrastructure (e.g., accounting and human resources management) through which operational processes can take place.

... The more types of ERP system modules implemented, the greater is the ERP system scope. Functional modules of an ERP system (accounting and finance modules, human resources modules) support functional processes of a firm's value chain and operational modules of an ERP system (customer and sales modules, supply chain modules) support operational processes of a firm's value chain. Every value chain process requires information processing tasks, which encompass the collection, manipulation, and transmittal of data necessary to conduct that process (Porter and Millar 1985). The respective modules of ERP systems perform the information processing tasks for the processes that they support (Barki and Pinsonneault 2005; Gattiker and Goodhue 2005). ERP systems are appealing because they facilitate streamlined information flows that connect individual modules; thus, economies of scope may accrue as ERP system scope increases.

... It is important for managers to know whether increasing ERP system scope pays off, because adopting a large-scope ERP system entails high financial costs and managerial complexity (Maruping, Venkatesh, and Agarwal 2009; Venkatesh et al. 2010).

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Part III

Governance & Management of IT

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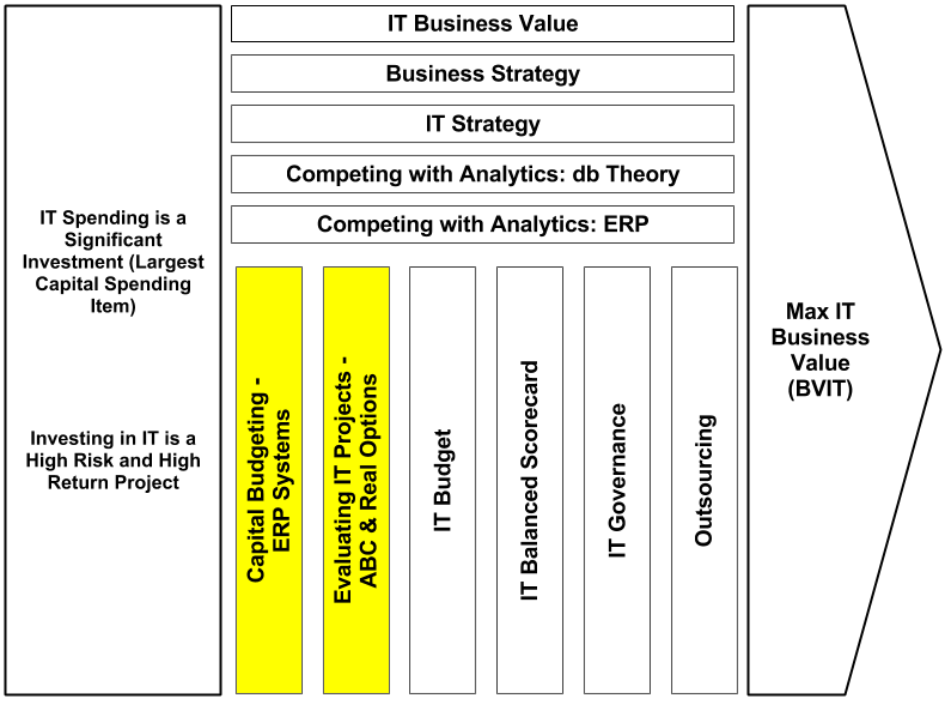
Chapter 7

Evaluation of IT Investments



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Learning Objectives

By the end of this chapter you should be able to understand and apply the following concepts:

- Review the justification of an ES implementation in the context of a large company, e.g., Whirlpool.
- Review the expected benefits of an ES implementation and relate them to appropriate accounting variables.
- Review the expected costs of an ES implementation and relate them to appropriate accounting variables.
- Perform the capital budgeting analysis.
- Leverage course material in order to generate different implementation related scenarios and explore their implications on the project's NPV.
- Leverage course material in order to generate different value extraction related scenarios and explore their implications on the project's NPV.
- Understand the limitations of NPV analysis.
- Consider the various risks associated with IT initiatives and their implications for the valuation of IT projects.
- Understand how flexibility in multi staged IT investment can be accounted for with the aid of real options.
- Estimate the approximate value of a real option.
- Evaluate an IT initiative using NPV and real options.

7.1 Introduction

For years managers, consultants, and academics have debated whether to measure the return on IT investments. While the debate is still going on, more and more CEOs and CFOs are demanding some form of evaluation before they approve a major IT project. The approaches that have been used for the evaluation depend on the evaluated project. In some cases it can be a simple back-of-the-envelope type of analysis, while in some other cases it can be more complex.

In general investments in enterprise systems (ES) tend to require more elaborate evaluation. Even for strategic IT investments, which tend to be justified based on 'gut feel' because of their urgency and intangible benefits, senior executives expect that their sponsors should be able to articulate the expected returns [161].

Evaluation of the expected benefits and expected costs has been one of the trademarks of IT capable firms. Evaluation of IT projects can serve mul-

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tiple objectives. First, it helps managers think carefully and try to quantify expected benefits as well as expected costs of proposed IT initiatives. Second, it makes managers suggesting such investments aware of the fact that there are limited resources, and preference should be given to projects that promise to deliver the highest payoffs. Third, it introduces an element of accountability as well as a benchmark for evaluating the actual performance of IT investments.

Capital budgeting is a systematic approach that firms use to evaluate investments in long-term assets such as ES in order to establish whether the expected payoffs outweigh expected costs. When it comes to the evaluation of IT investments, the typical toolbox includes such techniques as payback period, return on investment (ROI), internal rate of return (IRR), and net present value (NPV).

The payback period, as the name indicates, simply looks at the time (number of periods) it takes to recover the initial investment. Payback has three major limitations. First, it tends to favor short-term projects. Second, it does not consider returns that occur after the payback period. Third, it ignores the time value of money. Compared to payback period, the ROI (the ratio of net benefits over the invested capital) takes into consideration the entire lifecycle of an investment, but it does not account for the time value of money.

Both of these approaches (Payback and ROI) tend to be used when the need for a detailed analysis of an IT project is not very important. This is likely to be the case for IT initiatives which are relatively small in size and implementation time, and when the expected costs as well as the expected benefits are relatively clear.

The IRR (the actual rate of return from an investment or the interest rate that makes the present value of expected benefits equal to the present value of its costs) accounts for the time value of money, but depending on the cash flow a project may have more than one IRRs. NPV (the present value of all cash inflows minus the present value of all cash outflows of a project) does not have these limitations. Traditionally, NPV has been the tool for evaluating investment proposals. NPV and IRR are suitable and tend to be used for IT projects which are relatively large and their expected benefits/costs stretch over several years.

When it comes to evaluating IT projects, one of the major challenges is that of defining expected benefits. In the following section (7.2) we will use a mini-case based on an ES implementation at the BlueBike company and focus on the expected benefits (cash inflows) needed to perform the capital budgeting analysis using NPV. In section 7.3 we will consider some of the

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limitations of performing capital budgeting analysis on IT projects. We will explore real options as an alternative approach for evaluating IT projects in section 7.4.

7.2 Capital Budgeting Analysis

7.2.1 BlueBikes - ES Implementation

Three years ago, Madam Souza, the CEO of BlueBikes,[1] decided to acquire a small and relatively old manufacturing firm and start producing its own line of bikes. Response from retailer was positive, and Madam Souza decided to update some of the firms rather outdated equipment and information systems that BlueBikes had 'inherited' from the previous owner. A steering committee was formed to oversee the implementation and adoption of an ES. The committee chose to work with a local software company that specialized on small manufacturing firms.

The management of BlueBikes estimated that the ES adoption would generate the following benefits: First, the firm's profit margin would increase from its current level of 50% to 60%. Second, availability would increase from 90% to 99%. Third, the firm could reduce its Days Sales Inventory by 10 days. The company hopes to convert 70% of the increase in availability in sales. BlueBikes users will be able to attain 60% of the increase in availability as well as reduction in inventory in the first year, and the remaining 40% in the second year.

7.2.2 Cash Flow

In both NPV and IRR capital budgeting analysis, the emphasis is on cash flows rather than accounting income. The typical long-term investment will be associated with cash outflows and cash inflows. The implementation of an ES, like the one that BlueBikes considers, will require an initial cash outflow for the purchase of software and hardware. This will be followed by additional cash outflows during the implementation period to account for such expenses as consultants, employees dedicated to the implementation team, and training of users to the new software. Once the project has been implemented the firm will need to make regular payments for the maintenance of the new system as well as license maintenance fees.

On the other hand, the firm will consider making this kind of investment because it expects that will generate cash inflows. The typical inflows

[1] The case was introduced on p. 143.

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associated with investment in long-term assets are in the form of increased revenues, reduced costs, or release in working capital. More specifically, the adoption of an ES may generate one or more of the following cash inflows. Managers having a better and global view of the firm's operations will be able to manage better the firm's resources and be able to improve the quality of its products and customer service. This is likely to be reflected in the firm's ability to charge a higher premium for its products and/or increase its sales.

In parallel, the firm may be able to remove inefficiencies from its existing operations leading to a reduction of cycle time and cost. This will manifest in working capital reduction, e.g., the firm needs to carry a lower level of inventory in terms of raw materials or finished products, or other cost savings, e.g., less warehouse space, employee, and shipping costs.

Given the fact that it is relatively more difficult to capture cash inflows (i.e., expected benefits associated with IT initiatives) compared to cash outflows (i.e., costs associated with implementation and maintenance of IT initiatives), in the following section we are going to focus on cash inflows.

7.2.3 BlueBikes - Cash Inflows

In the following paragraphs, we are going to examine on the cash inflows that BlueBikes hopes to achieve from the ES implementation. The objective will be to identify each one of the potential benefits and see the cash inflow that will be generated as a result of these benefits.

We start with the state of the company prior to ES implementation. The firm sells 200 'units' at an average price of $500, and its average cost per unit is $250. Based on the above, we can calculate that the firm's revenues are $100,000, its cost of goods sold is $50,000, and its profits are $50,000.

Increase in Units Sold

One of the first benefits that we will examine is that of the increase in availability. BlueBikes estimates that due to the ES implementation the firm will be able to increase the availability of its products. In other words, the firm will be able to provide retailers with the kind of bikes they want. Current level of availability is 90%, and it is estimated that with the ES it can rise to 99%.

However, not all of this increase in availability will be translated into higher sales. Based on historical data the management of BlueBikes has estimated that about 70% of the increase in availability will be converted

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into new sales. Furthermore and in order to account for the users' learning curve, the management estimates that salespeople will be able to attain 60% of the conversion (availability to sales) in the first year and the remaining 40% in the second year.

Table 7.1 summarizes the key steps for estimating the new level of units sold due the increase in availability. The estimated additional units sold in the first year are 8.4. They are calculated as follows:

$$\begin{aligned} \textit{Additional Units} = & \textit{(Pre-ES Units Sold)x(Increase in Availability)x} \\ & \textit{x(Conversion Rate)x(Achieved Improvement 1st Year)} \\ & = \textit{(200)x(10\%)x(70\%)x(60\%)} = \textit{8.4} \end{aligned}$$

Similarly, we can estimate that the additional units sold in the second year are 5.6.

$$\begin{aligned} \textit{Additional Units} = & \textit{(Pre-ES Units Sold)x(Increase in Availability)x} \\ & \textit{x(Conversion Rate)x(Achieved Improvement 2nd Year)} \\ & = \textit{(200)x(10\%)x(70\%)x(40\%)} = \textit{5.6} \end{aligned}$$

The increase in availability will lead to 8.4 more units in year one and 5.4 in year two. Notice that there is no further increase in year three. The firm has achieved the full benefit of 14 additional units sold by the second year. As shown in Figure 7.1, the level of units sold as a result of the ES implementation will rise from 200 in the year before the ES implementation to 208 in the first year and 214 in year two. Again, notice that the units sold plateaus at 214 after the second year.

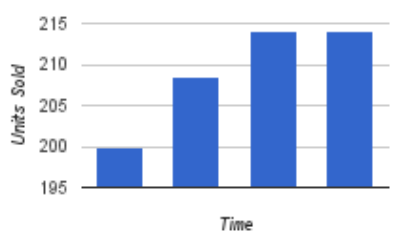

Figure 7.1: Additional Units sold

While the calculation of additional units sold is a benefit associated with the ES implementation at BlueBikes, it has to be converted into cash inflow in order to evaluate whether the investment increases the firm's value, i.e., it has a positive NPV. In the following paragraphs, we are going to combine the increase in units sold with the increase in the profit margin in order to generate the increase in revenues.

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Table 7.1: Increase in Units Sold Due to Increase in Availability

	Year = 0	**Year=1**	**Year=2**	**Year=3**
Pre-ES units	200	200	200	200
Pre-ES availability	90.00%	90.00%	90.00%	90.00%
Target Availability		99.00%	99.00%	99.00%
% Increase in availability		10.00%	10.00%	10.00%
Sales Conversion Rate		70.00%	70.00%	70.00%
Percentage Improvement		60.00%	40.00%	0.00%
Additional Units/Year		8.4	5.6	0
Cumulative Units		8.4	14	14
Post-ES units	200	208.4	214	214

Revenue Increase

The management of BlueBikes hopes that the ES adoption will provide them with a global view of the firm's extended supply chain and help them improve product quality and customer satisfaction. This in turn could be translated into higher prices. More specifically, they estimate that this will add 10% to their profit margin.

Based on historical data, we know that the firm's price is \$500 and its average cost of goods sold is \$250. Therefore the firm's profit margin prior to the ES implementation was 50%. With the ES implementation the profit margin will increase to 60%. Given that there is no indication of a change in the cost of goods sold, the new price will be calculated as follows:

$$\textit{Profit Margin per Unit} = \frac{\textit{Price per Unit - Cost of Goods Sold per Unit}}{\textit{Price per Unit}}$$

therefore,

$$\begin{aligned}\textit{Price per Unit} &= \frac{\textit{Cost of Goods Sold per Unit}}{\textit{1- Profit Margin per Unit}}\\ &= \frac{250}{1\text{-}0.6}\\ &= \$625.\end{aligned}$$

Table 7.2 summarizes the key steps used in the calculation of the new price level and sales (revenues). The pre-ES revenues were calculated as follows:

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$$\begin{aligned} Sales &= (Units\ Sold)x(Price\ per\ Unit) \\ &= (200)x(\$500) = \$100,000 \end{aligned}$$

Estimated revenues after the ES implementation were calculated as follows:

$$\begin{aligned} Sales\ \ First\ Year &= (Units\ Sold\ in\ First\ Year)(New\ Price\ per\ Unit) \\ &= (208.4)(\$625) = \$130,250. \\ Sales\ \ Second\ Year &= (Units\ Sold\ in\ Second\ Year)(New\ Price\ per\ Unit) \\ &= (214)(\$625) = \$133,750. \end{aligned}$$

Figure 7.2 shows that as a result of the ES adoption the firm could raise its average price from $500 to $625.

Notice that units sold and price remain the same after the second year, therefore the level of revenues remains at $133,750 after the second year.

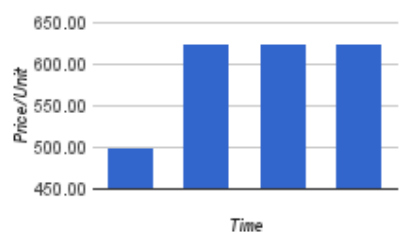

Figure 7.2: Price per Unit

Table 7.2: Pre- and Post-ES Implementation Revenues

	Year = 0	**Year=1**	**Year=2**	**Year=3**
Pre-ES Price	500	500	500	500
Pre-ES Cost	250	250	250	250
Pre-ES Margin (%)	50.00%	50.00%	50.00%	50.00%
Post-ES Margin Increase		10.00%	10.00%	10.00%
Post-ES Margin (%)		60.00%	60.00%	60.00%
Post-ES Price	500	625	625	625
Pre-ES Revenues	100,000	100,000	100,000	100,000
Post-ES Revenues		130,250	133,750	133,750

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Reduction in Inventory

The management of BlueBikes hopes that the adoption of the ES will help the firm improve its inventory management by establishing better communication links between the firm's manufacturing facility, its distribution center, and retailers (customers).

It is estimated that ES adoption will help the firm reduce the number of days it takes to sell its inventory (DSI) from 20 to 10. Figure 7.3 provides a graphical representation of the improvement that the firm will achieve. Notice that there is no further reduction in DSI after the second year.

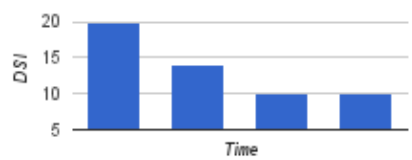

Figure 7.3: DSI Reduction

Table 7.3 provides the details for calculating this improvement. The DSI will be reduced by 6 days in the first year and 4 days in the second year. The reduction achieved in the first and second year were calculated as follows:

$$\begin{aligned} \textit{DSI Reduction} &= \textit{(Targeted Reduction)x(Achieved Reduction 1st Year)} \\ &= \textit{(10)(60\%)} = 6. \end{aligned}$$

$$\begin{aligned} \textit{DSI Reduction} &= \textit{(Targeted Reduction)x(Achieved Reduction 2nd Year)} \\ &= \textit{(10)(40\%)} = 4. \end{aligned}$$

Table 7.3: Improvement in DSI

	Year = 0	**Year=1**	**Year=2**	**Year=3**
Pre-ES DSI	20	20	20	20
Target DSI reduction		10	10	10
Percentage Improvement		60.00%	40.00%	0.00%
DSI Reduction in Year		6	4	0
Post-ES DSI	20	14	10	10

In order to perform the capital budgeting analysis, we will have to convert this reduction in the number of days it takes to sell the company's inventory into a cash inflow. Therefore, we need to estimate the firm's inventory level

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before and after the ES implementation. The estimated results shown in Table 7.4, were calculated as follows:

$$DSI = \frac{Ending\ Inventory}{\frac{Cost\ of\ Good\ Sold}{365}} \Longleftrightarrow$$
$$Ending\ Inventory = \frac{(Cost\ of\ Goods\ Sold)x(DSI)}{365}$$

Table 7.4: Inventory Reduction

	Year = 0	**Year=1**	**Year=2**	**Year=3**
Pre-ES units	200	200	200	200
Pre-ES COGS	50000	50000	50000	50000
Post-ES units	200	208	214	214
Post-ES COGS	50000	52100	53500	53500
Pre-ES Inventory	2740	2740	2740	2740
Post-ES Inventory	2740	1998	1466	1466
Inventory Reduction	0	741	1274	1274
Incremental Reduction	0	741	533	0

More specifically, and for each one of the years, we have the following figures:

$$Pre\text{-}ES\ Ending\ Inventory = \frac{(50000)x(20)}{365} = 2740$$
$$Post\text{-}ES\ Ending\ Inventory\ 1st\ year = \frac{(52100)x(14)}{365} = 1998,$$
$$Post\text{-}ES\ Ending\ Inventory\ 2nd\ year = \frac{(53500)x(10)}{365} = 1466.$$

Therefore, there is a reductions of inventory level of $2740 - 1998 = 741$ in the first year, and another reduction of inventory level of $1998 - 1466 = 1274$ in the second year. Notice that inventory level plateaus in the third year.

In order to calculate the NPV we need to work with flows rather than levels. In order to incorporate the effect of inventory reduction on the firm's cash flow, we need to consider the incremental amount of working capital

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that is released in each period. In the case of BlueBikes, there is an incremental cash inflow (cost savings) of $741 in the first year, and another $533 in the second year. There is no inventory related cash inflow in subsequent years (See table 7.4).

The use of capital budgeting analysis for the evaluation of IT initiatives is riddled with problems. In the following paragraphs we will try to understand some of these problems, their implications, and how to account for them in our analysis.

7.3 Limitations of Capital Budgeting Analysis

7.3.1 Measuring Expected Benefits and Costs

In order to perform capital budgeting analysis for a new IT initiative managers will have to identify the expected benefits of the proposed investment and convert them into cash inflows over the life cycle of the project. However, doing this conversion will depend on the nature of the expected benefits. These benefits can be tangible or intangible. In addition there may be benefits which are not immediately visible to the decision maker.

If the benefits are tangible, such as lower operations cost, lower facility cost, higher productivity, and lower inventory cost, it is relatively easy to quantify them and generate predicted values. The case of BlueBikes provided us with several examples of tangible benefits. However, most of the IT projects tend to generate a relatively high percentage of intangible benefits. Typical examples of intangible benefits are improved customer satisfaction, meeting legal requirements, empowering of users, and more timely information.

The reason that information systems generate intangible benefits has to do with the fact that they tend to be integrated along the company's value chain. As a result their value can only be manifested when these systems interact with several other resources and capabilities. Finally, it is likely that given the multitude of processes and users affected by the adoption of information systems, that some of these benefits, tangible or intangible, may be overlooked during the capital budgeting process.

While most managers are aware of the role of intangible benefits, there is no well defined approach on how to deal with them, and there are conflicted views on whether intangible benefits should be included in the evaluation of IT projects (See SideNote: Intangibles). Any attempt to quantify intangible benefits will require assumptions and development of heuristics models based on prior experience. Given the dynamic nature of the modern competitive

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environment these assumptions and models can be overturned rendering their predictions invalid.

Even though costs associated with IT initiatives tend to be easier to quantify, quite often managers fail to account for all possible costs. Most managers will tend to focus on cost of software and hardware. However, a study contacted by Meta Group in 2002 has shown that when it comes to ES implementations, this is just the tip of the proverbial iceberg. Managers must consider the direct as well as indirect costs associated with IT investments, i.e., the total cost of ownership (TCO).

SideNote: Intangibles

Intangibles are an emotional enigma to IT investment decision-making, and there are many different opinions on what to do about the non-quantifiable benefits put forth in defense of making an IT investment. Some of the typical opinions include: "They should be an integral part of credible IT project selection. They should be used as a tiebreaker only. Ban them entirely — they reflect wishful thinking. They are the only true decision factors and thus should drive everything." Not surprisingly, many decision teams, evaluation committees and business case members end up confused and frustrated concerning the approach they should take with such soft benefits.

Intangible has many meanings, depending on the context of its usage and the intention and viewpoint of the speaker. ... To an IT project selection team member, an intangible is a benefit arising from a proposed investment that is not or cannot be expressed in monetary terms. "Implementing this IT project brings a key intangible benefit — a vastly improved image of our organization with its customers, partners, investors and future employees." Within the context of IT investments, intangibility is a hot, disputed and often confusing issue ... The issue [is] not if intangibles should be included as an integral part of IT project selections, but how.[a]

[a] 77.

For ES implementation the TCO should account for hardware, software, professional services and internal staff costs. This means that one should account for the initial installation costs as well as the two year period that followed, which is when the real costs of maintaining, upgrading and optimizing the ES to the needs of the firms occur. The SideNote: Have You

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Calculated the Total Cost of Ownership indicates that the risk of underestimating cost remains valid in the era of cloud computing.

Regardless of its reason and justification, intentional or unintentional exclusion of expected benefits and costs from the evaluation process will inflate or deflate the net present value of the proposed IT investment. When it comes to intangibles, it has been suggested that managers should generate different scenarios and see how these scenarios would affect the NPV of the proposed project.

SideNote: Have You Calculated Total Cost of Ownership?

A late 2007 Forrester Research survey of North American and European software IT decision-makers found that "total cost concerns" was the second-most cited reason for why companies were not interested in SaaS. In the rush to adopt SaaS, some companies may forget about potentially conflicting total cost of ownership figures. For example, TCO of "SaaS ERP suites likely will be significant and may not compare favorably with on-premises solutions," writes Ganly, in the Gartner report. This problem applies to vendors as well. SaaS vendors "often have unrealistic expectations of their operating costs," she adds. "The multi tenant architecture needed for SaaS ERP suites results in high internal efforts and costs for the initial setup and the ongoing maintenance and upgrade of the system." Bottom line: If the SaaS deal seems good to be true and the TCO calculations too rosy, the overall deal may be just that: Too good to be true.[a]

[a] 166.

7.3.2 Assessing Riskiness

In the typical evaluation of a capital investment, the cash flow of expected benefits and expected costs is discounted by the firm's cost of capital (i.e., risk adjusted discount rate). The discount rate typically accounts for such things as the market's perception of the financial risk of the organization's activities and the firm's financial structure (debt and equity financing). However, there are several other risks associated with IT initiatives. The typical IT investment may be exposed to one or more of the following risks:

- **Technical risk**. The firm is investing in a new project that relies on new technology that has not been tested or requires technology

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that has not been fully developed yet. The technical staff as well as the management of the company will not be able to generate accurate predictions regarding implementation time and budgeted resources.

- **Project risk**. The likelihood that a project will be completed on time, on budget, and with the desired functionality is inversely proportional to the scope of the project. The larger and more complicated the scope of the project the higher the likelihood that the project will fail.
  However, the relation between risk of failure and scope of the project is contingent upon the firm's prior experience. For a firm that has experience working with multi million dollar projects, involving multiple geographic locations, and thousands of users; working on an ES implementation, may be of relative low risk. On the other hand; for a small firm with no IT capability, implementing a single ES module in one geographic location may be a risky undertaking.
- **User related risk**. The evaluation of an IT investment hinges upon the expectation that users will adopt the proposed IT solution and will be able to extract the expected value from this investment. However, it is possible that the developers may have failed to capture properly users' needs or users may not have been involved in the development process. Finally, it is quite possible that users may feel threatened by the new IT solution, i.e., fear of being replaced by an automated process, and refuse to participate in the development and adoption of the proposed solution.
- **Systemic risk**. The proposed IT initiative may precipitate a structural change in the firm's competitive environment with unanticipated implication for the firm. Typically this is associated with 'transform' type of IT initiatives (see discussion in Chapter 3, p. 83). While, these kind of changes tend to be detrimental to competitors rather than the firm itself, it is possible that the firm's IT initiative may precipitate an unanticipated reaction from competitors, customers, suppliers, or regulatory agencies.

While these are valid reasons to adjust the discount rate used in the evaluation of IT investments, Ballantine and Stray (1998) report that only a small percent of firms (around 7%) make such an adjustment. Failure to adjust for the risk of IT initiatives may have adverse effect in the portfolio of IT projects that a firm selects. A firm with a superior IT capability may be too conservative in its portfolio selection. On the other hand, a firm with poor IT capability may end up having a portfolio of very risky IT initiatives. It has been recommended that managers should perform a

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sensitivity analysis in order to assess the effect of different discount rates in the NPV of a proposed IT initiative.

7.3.3 Interpretation

There are two main messages that emerge from the above discussion. First, the evaluation of the project should take into consideration the fact that all expected benefits and expected costs are based on assumptions prepared from people who may have a vested interest in the adoption of a certain project. An IT executive from the finance industry warns that today's IT groups make too many ROI guesstimates, they have too little accountability, and the 'ROI numbers are mostly fiction' (Meshing 2013). The same executive warns that '... In most companies, determining the potential costs and benefits of a tech investment is neither art nor science. Rather, it's an elaborate and often dishonest marketing exercise aimed at persuading senior stakeholders ...'

The second message is regarding the need to supplement the NPV evaluation of a proposed IT initiative with a sensitivity analysis. The completion of the NPV analysis, regardless of its end result (positive or negative NPV), should be followed by sensitivity analysis. For example, our discussion in section 7.2.3 was based on the assumption that everything would go well. However, as we have seen in Chapter 6 things may not go as planned. You should be prepared to account for possible failures and incorporate them in your analysis. Take a look at the practice problem 9 on p. 220 and see how this relates to this discussion.

7.4 Real Options

7.4.1 Flexibility as an Option

Agility (or flexibility), i.e., ability to respond to changes in competitive environment, is one of the often-mentioned benefits associated with IT investments. Consider the following two examples: First, firm A has invested in an enterprise system (ES) in the past. If the right opportunity arises for firm A to integrate its supply chain with that of a customer or supplier, the firm will be able to do it relatively easy. As we have seen in Chapter 3 (p. 79) the benefits of such an integration through the implementation of software like Collaborative Planning Forecasting Replenishing (CPFR) are substantial. Therefore, this flexibility contributes to the competitive advantage that firm A has versus competitors that have not invested in an ES.

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For our second example we are going to consider firm B that has developed a data warehouse that contains detailed information about customers, their preferences, purchasing patterns, loyalty, etc. The firm can invest in appropriate BA tools (i.e., sentiment analytics) in order to gauge relevant revealed feelings of consumers in social networks. This analysis may reveal their feelings towards firm B, its products, and management practices. The results of this sentiment analysis can be integrated with structured data from the data warehouse in order to respond to customer needs or develop new products. As we have seen in Chapter 1 (p. 11) BestBuy was able to leverage the feedback from such sentiment analytics to realize how unpopular its 'restocking fees' were. More research revealed that these fees were unpopular among the group of most profitable and influential customers.

Both of these examples show that a firm's flexibility (ability to make the appropriate investment needed to exploit an opportunity – e.g., CPFR or sentiment analytics) depends on whether the firm has already completed the first investment. Using the terminology from resource-based view (RBV), we can say that investments such as CPFR and BA/sentiment analytics are path dependent. Competitors that want to exploit similar opportunities will have to first invest in the ES or development of a data warehouse. Therefore, the flexibility afforded is very important because investments in such path dependent resources are a source of sustainable competitive advantage.

Two very important messages emerge from both of these examples. First, When firm A considers the investment in the ES does not have to decide whether to invest in the CPFR or not. The investment in the ES provides the firm with the option, but not the obligation to invest in the CPFR at a future point, if and only if the investment at that point is profitable. If at the future point, the CPFR investment is not profitable the firm does not have to make the investment.

Similarly, when firm B considers the investment in the data warehouse, the firm does not have to decide whether to invest in BA tools. At some future point, if the conditions are such that investing in BA tools presents a profitable opportunity firm B will make the investment. Second, the traditional NPV analysis does not allow us to incorporate the element of flexibility (option but not obligation) to continue with a second stage of an investment, if and only if the conditions are right.

From a management standpoint NPV analysis has been described as buy and hold type of approach. In other words, managers cannot and will not try to influence the future direction of an IT investment. Real options is an alternative evaluation method that is built on the premise that managers will take a more active role and try to influence the future direction of an

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undertaken investment.

7.4.2 Financial Options

Most of you are familiar with options on financial assets. You know that an option is the right, but not the obligation, to buy or sell a certain financial asset at future date at a predefined price. An option to buy is a call option while an option to sell is a put option. A call option [2] gives you the right, but not the obligation, to buy a stock at a definite price (known as the strike price) for a limited period of time.

For example, lets say that the stock price of a firm today (July 5th) is \$52.02. For \$2.50 you could buy a call option that gives you the right at any time from now and until the January 15, to buy a share of this company for \$50 per share. If during this period the price of stock rises to lets say \$62 you could purchase the stock for the strike price of \$50, and earn a profit of \$7.50 (60-50-2.50). However, if during the period the price does not rise above \$52.50, you will not exercise your option and the value of the option will become zero on January 15.

It has been proven that the value of option depends on the following five factors: [3]

- S= the value of the stock on which a stock option is written,
- X = the option's exercise price,
- T = the time to an option's maturity (duration of an option),
- σ^2 = the variance in the price of the stock on which an option is written, and
- r_f = the risk-free rate.

The value of an option can be calculated using the Black-Scholes formula. If you have the values for these five variables, you can use one of the online calculators to generate the value of the call option.

Figure 7.4 shows an example of such a calculator using the following values: $S = 55$, $X = 50$, $T = .5$, $\sigma = 20\%$, and $r_f = 2.5\%$. The estimated value of the financial call option with these values is \$ 6.566. The calculator can be accessed from http://www.mystockoptions.com/black-scholes.cfm

[2] The examples below refers to an American call option

[3] Valuation of options is covered in more detail in investment classes (financial derivatives).

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7.4.3 Real Options

Notice that the ability to postpone the decision about whether or not to buy a stock up until January 15 is what introduces flexibility into this financial option. With the following example we will try to show that this is similar to the flexibility that firms A and B in the examples above can exploit through real options. Suppose that a retail firm considers a $200 investment in an integrated point of sales system (POS). The firm could leverage its POS to record sales and manage its inventory. The immediate effect of this investment in the POS is that the firm can generate its financial reports faster and more accurately, and be more efficient in the way it manages its inventory.

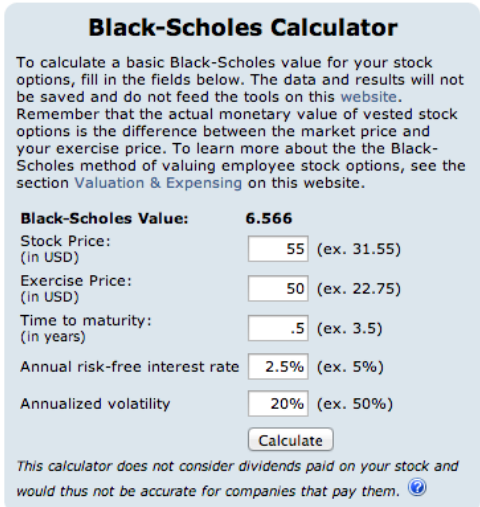

Figure 7.4: Calculator - Financial Option

However, it may also have the effect of enabling the firm through the appropriate investment in business analytics (BA) tools to mine its sales data that could, at some future date, lead to more sales and higher profits. This means that the opportunity to leverage the dataset in order to achieve higher sales and profits in the future via the appropriate BA investment, is a real option associated with POS investment. Recall that the data set was generated as a result of the investment in the POS with the aim to simply support sales transactions and manage inventory.

Now suppose that, given that this firm has already invested in the POS, it would cost an additional $100 to invest in the BA tools and mine its own data. This is the exercise price of the real option. If, at some point in the future, the net present value of incremental revenues that the firm could generate as a result of mining its sales data becomes greater than $100, then this firm will exercise its real option, invest in BA and mine its sales data. At this point, this firm will be able to buy incremental revenues (cash flows), which are worth more than $100 for $100.

On the other hand, if the net present value of incremental revenues that

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the firm could generate as a result of mining its sales remains below $100, then the firm will never exercise this real option. At some point, when the POS this firm has invested in becomes obsolete, this real option will expire. Notice that, as with financial options, the firm does not have to decide whether proceed with the investment in BA tools until after uncertainty about the net present value of the incremental revenues that the firm could generate as a result of mining its sales data is reduced. The original POS provided the firm with an additional degree of freedom and flexibility on the decision to invest in BA tools.

7.4.4 How to Value a Real Option

Valuation of real options is problematic for several reasons: First, the assets are not traded, which means that it difficult to generate the value of the assets and variance in the value of the asset. Second, the real options do not have a predefined expiration date and exercise price. The option to exercise may depend on market conditions and may be influenced by such factors as actions of competitors, customers or vendors. While it is not easy to specify the five variables needed in order to calculate the value real options based on the Black-Scholes formula, it is possible to generate an approximate value.[4]

We will use the example of the two-stage investment shown in figure 7.5 to demonstrate this. At time zero, a retail firm invests $200 to a POS. This investment generates the cash flow shown in the top panel of figure 7.5. The net present value of the first stage is $9.02 based on a discount rate of 9%. Then, in Year 3, this firm can invest an additional $100 in BA tools. The present value of the cash flows associated with the second stage of this project is -$12.84.

Based on the traditional NPV approach, the NPV of the entire project is -$3.84 and the firm should not invest in the IT initiative. The underlying assumption in NPV analysis is that the firm will have to decide whether to invest in the POS and the BA tools at the same time. The NPV analysis does not incorporate the option that the firm can delay the investment in BA tools until the 3rd year. As we have seen above, this flexibility (real option) is valuable and we should take it into consideration when we evaluate this project.

In order to approximate the value of the real option using the Black-Scholes model we will need to complete the following steps:

1. We use the guidelines shown in table 7.5 to map the five parameters

[4]This section is based on Barney [5].

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Stage One						
Year	**0**	**1**	**2**	**3**	**4**	**5**
Cash Flow	-$200.00	$50.00	$53.00	$55.00	$56.00	$56.00
Present Value	-$200.00	$45.87	$44.61	$42.47	$39.67	$36.40
NPV	$9.02					
Stage Two						
Year	**0**	**1**	**2**	**3**	**4**	**5**
Cash Flow	$0.00	$0.00	$0.00	-$100.00	$45.00	$50.00
Present Value	$0.00	$0.00	$0.00	-$77.22	$31.88	$32.50
NPV	-$12.84					
Combo						
Year	**0**	**1**	**2**	**3**	**4**	**5**
Cash Flow	-$200.00	$50.00	$53.00	-$45.00	$101.00	$106.00
Present Value	-$200.00	$45.87	$44.61	-$34.75	$71.55	$68.89
NPV	-$3.82					

Figure 7.5: Two Stage Investment

needed (S, X, T, σ, and r_f) in the Black-Scholes formula between financial options and real options.

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Table 7.5: Mapping Financial to Real Option

Financial Option	**Real Option**	**Value Example**
S= the value of the stock on which a stock option is written	Present value of cash inflows generated by investment in the second stage.	\$64.38
X = the option's exercise price	Investment that the firm has to make if it chooses to exercise its option in the second stage.	\$100
T = the time to an option's maturity (duration of an option)	How long could the firm delay the decision for the second stage?	3 years
σ^2 = the variance in the price of the stock on which an option is written	Based on managers' estimates	40%
r_f = the risk-free interest rate	Risk free rate	5.5%

While the mapping between the rest of the variables is relatively simple, generating the variance requires manager's estimates. Barney [5] suggests the following:

"... First, using their prior experience, managers can estimate how uncertain the cash flows associated with exercising a real option in the future are likely to be and choose an appropriate value of σ^2. Uncertain cash flows should have a σ^2 equal to around .09; more uncertain cash flows should have a σ^2 equal to around .20; and still more uncertain cash flows should have a σ^2 equal to around .36.

Second, if managers do not have prior experience to guide them, they can estimate all the Black-Scholes parameters associated with a real option except σ^2. Then, various values of σ^2 can be used to calculate the value of the real option. By examining the relationship between cash flow uncertainty and real option value, managers can decide whether or not to invest in a real option. For example, if the only way a real option has a significant positive value is if the cash flow uncertainty associated with that option is very high (e.g., $\sigma^2 = .5$), risk averse managers might decide that investing to create this real option is not worthwhile. Alternatively, if a real option is valuable even when the cash flow uncertainty associated with it is quite low (for example, $\sigma^2 = .02$), even risk-averse managers would probably be

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willing to invest to create this real option."

By entering the values from table 7.5 in the online calculator, we have that the value of the real option is $50.84.

2. To see if valuing the above investment as a real option creates any extra value for the firm, it is necessary to establish a benchmark. This benchmark is the result of the traditional NPV analysis. In our example this is -$3.82.

3. Calculate the full present value of the project, i.e., the present value of stage one (that the firm has to decide at the present moment) plus the value of the real option. In our example this is $21.70+$9.02=$30.73.

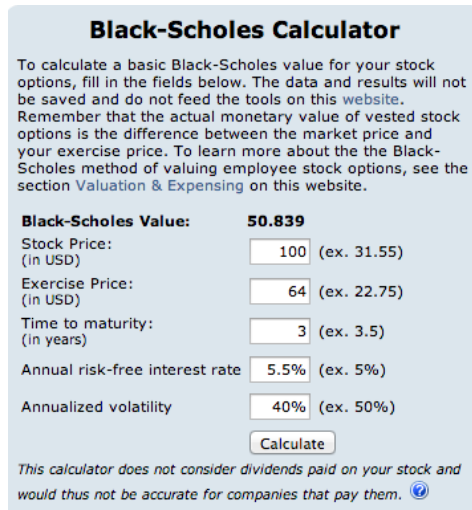

Figure 7.6: Calculator - Real Option

4. Compare the full present value ($59.86) with the Benchmark Value (-$3.82). Clearly the former is much higher than the latter. This indicates that there is value associated with the real option that is created by investing in the POS and then delaying the decision about whether or not to invest in BA tools 3 years. While NPV suggests that the firm should not invest in POS project, real options suggest that it should.

7.4.5 Concluding remarks

1. Real options address some of the limitations of NPV analysis.

2. Real options allow managers to take into consideration the volatility in the value of IT projects over time, the optimal timing of the investment, and the fact that technology prices decline over time.

3. Real options place value on management learning.

4. Real options are more valuable when the future is very uncertain, e.g., when you invest in new and untested technology. Hint: See what happen to the value of the option when volatility increases.

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5. The main disadvantage of real options is the estimation of all five variables, especially the expected cash flows from the underlying asset and changes in the cost of implementation.

7.5 Business Value: Accounting/Finance Angle

Given the nature of this chapter there is no need to introduce an explicit accounting/finance angle.

7.6 Summary and Concluding Remarks

In this chapter, we examined some issues related with the evaluation (capital budgeting) of IT projects. While capital budgeting is a topic that you will cover in more detail in financial management or managerial accounting, our focus was on certain issues that are salient on IT projects. More specifically, we looked at typical cash inflows associated with adoption of ES and some of the most common limitations of using NPV analysis to evaluate IT projects. The chapter closed with an introduction to real options as an alternative to NPV analysis.

While in this chapter we have concentrated on individual IT initiatives (recall that from a capital budgeting/NPV standpoint even a multi stage project is an individual project), it is clear that at any given time a firm may have to consider and prioritize the funding of multiple projects. In the following chapter we are going to consider at the IT budget and the portfolio of its IT initiatives.

7.7 Practice Questions and Problems

7.7.1 Study Questions

1. The authors of the article reported in the News Based Context and Perspective state that "*The fundamental insight of net present value is double-edged: The later the cost savings from not suffering cyber-crimes, the less it's worth. At the same time, the sooner the investment in cybersecurity, the more it costs.*". What did the authors use the term 'double-edged'?
2. In general investments in enterprise systems tend to require more elaborate evaluation. Explain why.

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3. Strategic IT initiatives tend to be characterized by urgency and intangible benefits. Why?
4. On page 199 it is stated that evaluation of IT initiatives introduces an element of accountability as well as a benchmark for evaluating the actual performance of IT investments. What does this mean?
5. Why Payback period tends to favor short-term projects?
6. As we have seen on p. 206 the inventory level went from 2740 in the pre-ES period to 1466 in the second year of implementation. Can we use the difference of the two numbers as the amount of working capital that was released (cash inflow) in the second year?
7. A commercial shows a classroom where students use different forms of technology, e.g., desktops, laptops, tablets, and the caption says that the company's systems help reduce the time teachers spend troubleshooting IT problems by 70%. How does this information relate to evaluation of an investment in the firm's systems?
8. Using an online calculator such as the one shown on p. 7.4, try to understand how the five variables of the Black-Scholes model affect the value of an option. Which one of these variables has the largest effect?
9. Working on the case of Whirlpool Europe a team of AFM241 students[5] prepared the two graphs shown in Figure 7.7. What each of the three colored lines mean in these figures? How will these scenarios affect your NPV analysis?

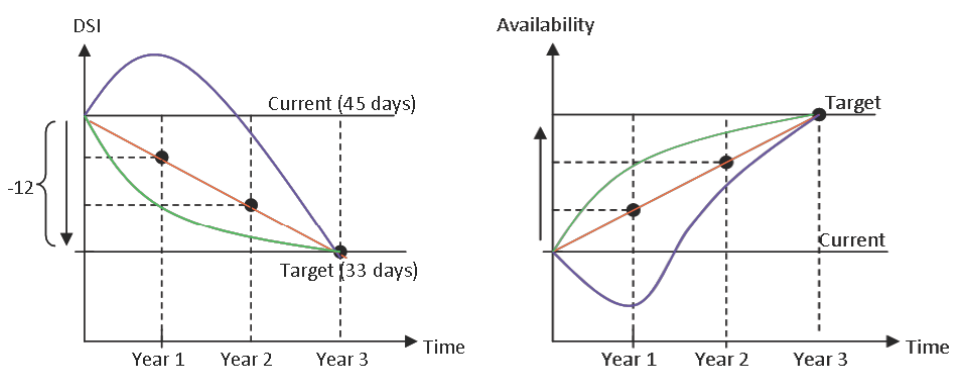

Figure 7.7: DIS and Availability Paths

[5]Ying Yan Jiang, Kar Yee Lau, Christina Ng, Robert Nguyen, Savdeep Rai (AFM241 - Spring 2009)

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7.7.2 Multiple Choice Questions

1. The pre-ERP units sold are 100, PRE availability was 70% and post ERP availability was 95%. The company assumes that they can convert all the increased availability into sales and they can attain 40% of the increased availability the first year of implementation and 60% in the second year of implementation. However, in the first year of implementation they managed to attain 10% of the increased availability, 40% in the second year, and 50% in the third year. Assuming that everything else remains the same, the NPV will ...

   (a) decrease
   (b) stay the same
   (c) not enough information
   (d) increase

2. A company considers implementing an ERP system and the implementation will be completed in one year. The expected benefits are an increase in its margin by 5% and its availability from 70% to 84%. The company hopes to convert 50% of the increase in availability in sales and the users will be able to attain 40% of the increase in availability in the first year and another 60% in the second year. The pre-ERP figures are as follows: Units=100; Price=$5; Cost per unit=$4. The ERP implementation is not likely to affect the company's DSI which is currently at 40 days. The new price after ERP implementation will be _____.[6]

   (a) 5.3
   (b) 5.8
   (c) 6.2
   (d) 6

3. A company considers implementing an ES system and the implementation will be completed in one year. The expected benefits are an increase in its margin by 5% and its availability from 70% to 84%. The company hopes to convert 50% of the increase in availability in

[6]Hint: Consider the formula we have used on page 203:

$$\textit{New Profit Margin per Unit} = \frac{\textit{New Price per Unit - Cost of Goods Sold per Unit}}{\textit{New Price per Unit}}$$

$$\iff \textit{New Price per Unit} = \frac{\textit{Cost of Goods Sold per Unit}}{\textit{1- New Profit Margin per Unit}}$$

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sales and the users will be able to attain 40% of the increase in availability in the first year and another 60% in the second year. The pre-ES figures are as follows: Units=100; Price=$5; Cost per unit=$4. The ES implementation is not likely to affect the company's DSI which is currently at 40 days. The percentage increase in availability is _____.

(a) 14%
(b) 40%
(c) 20%
(d) 60%

4. A company considers implementing an ES system and the implementation will be completed in one year. The expected benefits are an increase in its margin by 5% and its availability from 70% to 84%. The company hopes to convert 50% of the increase in availability in sales and the users will be able to attain 40% of the increase in availability in the first year and another 60% in the second year. The pre-ES figures are as follows: Units=100; Price=$5; Cost per unit=$4. The ES implementation is not likely to affect the company's DSI which is currently at 40 days. The increase in availability will generate _____ additional units in the first year and _____ additional units in the second year.

(a) 14 and 28
(b) 3 and 4
(c) 4 and 6
(d) 40 and 60

5. A company considers implementing an ES system and the implementation will be completed in one year. The expected benefits are an increase in its margin by 5% and its availability from 70% to 84%. The company hopes to convert 50% of the increase in availability in sales and the users will be able to attain 40% of the increase in availability in the first year and another 60% in the second year. The pre-ES figures for ABC are as follows: Units=100; Price=$5; Cost per unit=$4. If the DSI remains the same before and after ES implementation (at 40 days) the company's inventory will _____ after the ES implementation.

(a) increase
(b) decrease
(c) stay the same
(d) There is not enough information.

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7.8 Business Analytics Practice Problems

7.8.1 Whirlpool: Sensitivity Analysis

From: Whirlpool Europe - Board of Directors
Subject: Sensitivity analysis

The board of directors would like to thank you for your excellent capital budgeting analysis for the ERP project. Your analysis was very thorough, well presented, and very illuminating for the board members.[7]

While the results seem straightforward (NPV>0) the board is not ready to provide its final approval on the project. Several members have been alarmed by the supplemental information you brought at the meeting. The results from the CHAOS report and the stories of FoxMeyer and Hershey's in particular have made several members question the entire project. Given the magnitude of the ERP investment and its huge implications for the company, the board would like you to continue working on the project and prepare a sensitivity analysis/report for its next meeting (July 25th, 2012 at 10:00 AM).

The board would like to know "what are some of the issues that they (the board) should be aware of, how they will affect the NPV results, and suggestions on how to deal with these issues?" Looking forward to your report.

The Board of Directors of WP-Europe

Details about the project The objective of the data analytics exercise is to make us realize that the NPV of the Whirlpool Europe project is based on the assumptions generated by the managers of the company.

The calculated NPV in the case of Whirlpool, and for that mater for any ES implementation project, is based on assumption that implementation will go as planned, users will be able to extract value from this investment, and management's assumptions about the IT project are correct.

History, has shown that this is not the case. Hence, the objective of this exercise is to help us understand and quantify these risks. To achieve this we will run, a 'crowd sourced Monte Carlo simulation,' that involves the following steps:

1. Start by reviewing the material on implementation capability (pp. 95-96) and some of stories on ES implementation failures (pp. 171-176).

[7] Team Assignment - Spring 2012

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2. Review the Whirlpool capital budgeting spreadsheet and identify/-make a list of areas where a ERP implementation failure may manifest.
3. For each one of these areas/variables, we will write down the current value and generate a range of reasonable values that we should expect if something were to go wrong. We use our experience from the review of implementation readings (item 1 above) to establish a range of reasonable values. We may want to find a copy of one of the old Chaos reports to see some of the range of values they use.
4. Working in groups start by experimenting with values for one of these variables and record the NPV associated with each value.
5. Collect the data from all teams, and we should have a data set with implementation failure related variables and corresponding NPV values.
6. Run multiple regression analysis to predict the expected effect of changes in these drivers on NPV. Interpret our coefficients.
7. Use descriptive analytics and data visualization tools to communicate with managers the implications of unmitigated risks during and after implementation on the expected value of the IT investment.
8. Tell a story based on our analysis. Suggest appropriate actions that the board can take to deal with these issues. For example, you may want to suggest that the board should cancel the ERP project. The risk is too high because ....

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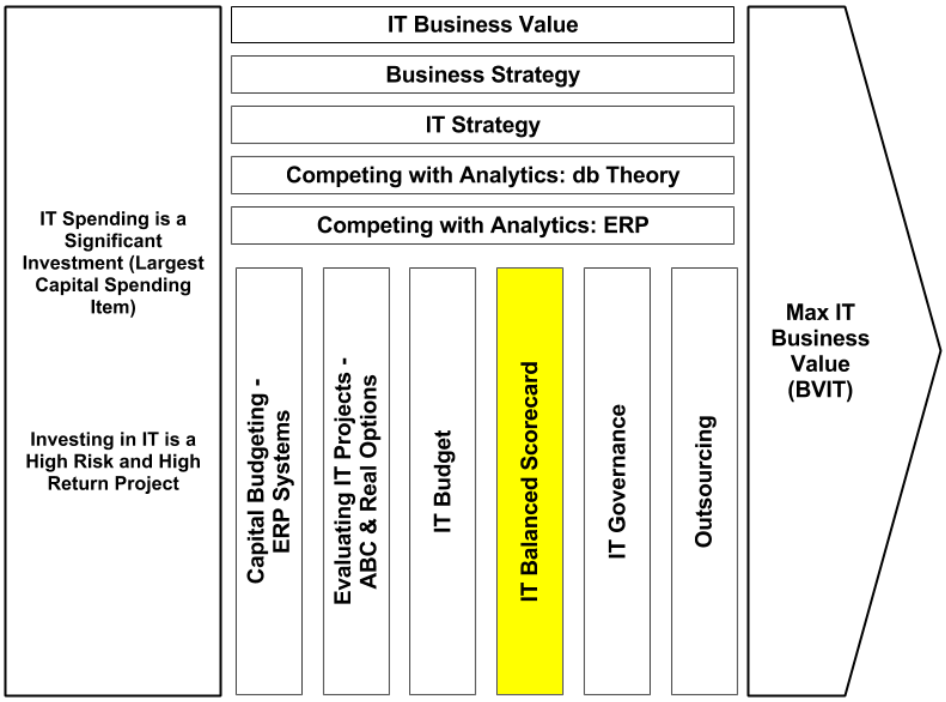
Chapter 8

Monitoring IT



Theophanis C. Stratopoulos, University of Waterloo

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Learning Objectives

By the end of this chapter you should be able to understand and apply the following concepts:

- Causality in DuPont Analysis and its limitations.
- Causality in expected payoffs from IT investments.
- The Balanced Scorecard
- How to link strategy to action with a balanced scorecard.
- Four perspective of the balanced scorecard.
- Leading and lagging indicators in a balanced scorecard.
- IT balanced scorecard.
- Balanced scorecard for ERP implementation and ERP use.

8.1 Introduction

DuPont analysis provides managers and investors with a bird's eye view of the financial performance of the company. You can decompose a firm's ROA in order to see the source of a change. For example, if you look at a firm's ROA and you observe an increase compared to prior period, you can start decomposing the ROA into its two parts (Profit Margin and Asset Turnover) in order to find the source of this change. If the increase in ROA was due to a change in the firm's profit margin, you can decompose it to its components (NI and sales). You can continue by further decomposing the NI into its components (sales, cost of good sold, and selling and general administrative expenses) until you reach the source that contributed to the change in ROA.

A couple of important messages emerge from this analysis. First, if you understand the logic behind these formulas and link to it appropriate processes within the firm, you can dig further in order to identify the source of a change. Any decisions and related actions should aim at the source rather than the effect. Second, there are several non financial factors (e.g., intangible assets) that may have affected the ROA increase which are not captured in the DuPont analysis. We cannot use accounting variables and DuPont analysis for benefits which are not quantifiable.

As we have seen in Chapter 7, investment in enterprise systems (ES), and in information technology in general, are bound to generate numerous intangible benefits, such as improved customer service, technical and managerial skills, knowledge-based assets which are difficult to quantify. When it comes to managing and monitoring investments in IT, this becomes prob-

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lematic because as the old management aphorism goes 'if you can't measure it, you can't manage it.'

The need to look beyond financial accounting measures in order to capture a more holistic view of a firm's performance, led to the introduction of the balanced scorecard. A performance management tool that is based on the cause and effect approach in order to measure and manage all aspects of a company's performance. In the rest of this chapter, we are going to start with a brief introduction to the balanced scorecard, and proceed exploring how the balanced scorecard can be used to monitor IT investments.

8.2 Balanced Scorecard

The balanced scorecard is a system for measuring and managing all dimensions of a firm's performance. It is recognized as a tool that aims to help managers align performance management initiatives with strategy, by translating a firm's strategy into clear objectives, measures, targets, and initiatives. The name 'balanced' indicates that it combines traditional financial measures of performance with non-financial drivers of future financial performance. The balanced scorecard provides an interconnected model for measuring performance that revolves around the following four perspectives:

1. Financial perspective: How is success measured by our stakeholders? How do we look to our shareholders?
2. Customer perspective: How can we create value for our customers? How do customers see us?
3. Internal processes perspective: What must we excel at to create value for our customers?
4. Learning and Growth perspective: Can we continue to improve and create value? What employee capabilities, information systems, and organization climate do we need in order to continually improve our internal processes?

8.2.1 Strategy Map

A strategy map provides a visual representation of the linkages among these four areas of the balanced scorecard. For example, consider the strategy map shown in Figure 8.1.

The financial perspective focuses on maximizing shareholder value. Shareholders' concerns tend to fall into two categories, short-term (value) and long-term (sustainability). Typical financial measures include cash flow,

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Figure 8.1: Strategy Map (Source: Wikipedia)

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sales growth, operating income, market share, and ROA or ROE. Using the financial measures as the effect, our goal is to identify potential drivers that could affect these financial measures. As shown in Figure 8.1, these drivers stem from the customer perspective.

The customer perspective identifies objectives and measures for the firm's customers, and the firm's value proposition for them. Customers needs and concerns tend to fall into four categories: time, quality, performance/service, and cost. To put the balanced scorecard to work companies need to articulate their objectives, i.e., what the firm hopes to accomplish, for time, quality, performance/service, as well as cost, and translate these goals into specific measures. For example, a firms cash flow and/or sales growth is likely to be driven by repeat and new sales from existing customers, which are the result of high level of customer loyalty and customer satisfaction (exceed customer expectations). In the strategy map, it is clear, that the drivers of customer related measures stem from the firm's internal processes.

The internal perspective identifies and measures the performance of internal processes that are pivotal in the firm's ability to add value to its customers and achieve the desired financial objectives. Managers need to focus on those critical internal operations that enable them to satisfy customer needs. Companies need to decide what processes and competencies they must excel and specify measures for each.

In the context of our strategy map, this translates to such questions as how does the firm increase customer loyalty and exceed customer expectations? The answer to this question, and the drivers for consumer related measures, stem from the firm's ability to create high quality products, through efficient and effective operations, and working with quality partners.

One can see this by following the firm's value chain. A firm through its R&D operations will generate ideas for new products that the customers want. The firm's procurement process will ensure that the firm is using high quality raw materials. The firms operations will ensure that the products are generated efficiently.

Finally, one can ask the question: How does a firm achieve such an integration in its value chain? In other words, what are the drivers of measures related to the firm's internal processes? The learning and growth perspective identifies the objectives for employee capabilities, information systems, and culture that will enable future growth. A company's ability to innovate, improve, and learn ties directly to the company's value chain. That is only through the ability to launch new products, create more value for customers, and improve operating efficiency that a firm can enter into new markets and increase revenues and margins. In short, grow and increase

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shareholder value.

8.2.2 BlueBikes: Causality Example

The element of causality, demonstrated through a strategy map, is critical in the development of a balanced scorecard. For example, if we were to revisit the BlueBikes company, profitability is one of the typical balanced scorecard measures that should be included in their financial perspective.

The next step would be to look for drivers of profitability in the customer perspective. Customer loyalty is such a driver. BlueBikes relies on a short list of retail stores, therefore repeat sales from existing stores and an expanding volume of sales from these stores is something that could increase the profitability of the company. Therefore a measure of customer loyalty should be included in the customer perspective of the balanced scorecard.

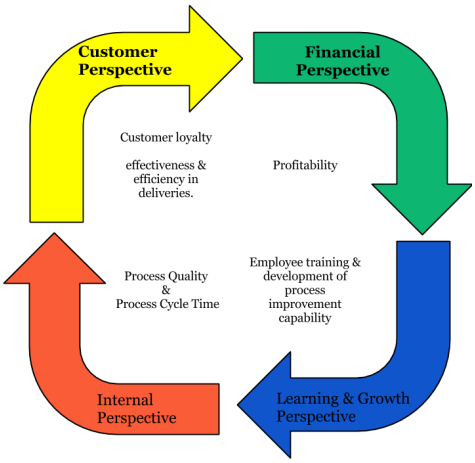

Figure 8.2: Cause and Effect

The company believes that customers care about effectiveness and efficiency in deliveries. This means that retail stores rely on BlueBikes to provide them with the right mix of products, at the right time, and at a reasonable price.

The cause and effect relationship at BlueBikes continues with the internal processes perspective by identifying areas the company must excel in order to achieve the effectiveness and efficiency in deliveries. The firm has identified the following two drivers: process quality and process cycle time. Therefore, measures related to these two objectives should be added in the firm's balanced scorecard.

Finally, we must identify drivers that can help BlueBikes to achieve its internal perspective objectives. In order to improve its process quality and its process cycle time, the firm must have skilled employees and develop capabilities in process improvement. Therefore measures related to firm's efforts to develop employee skills, e.g., training, should be included in the learning and growth perspective.

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8.2.3 Alignment between Strategy & Operations

One of the main benefits of developing and using a balanced scorecard is that of aligning the firm's strategy to its operations. David Nolan[1] describes the role of balanced scorecard as an enabler of alignment as follows [61]:

> Alignment is about creating an approach and a framework that lets the organization define what's important and then cascade that and communicate that to the lower levels of the organization so everybody understands what the strategy is and how they fit in. If you don't link strategy management and operations management, then you're stuck in either a bottoms-up world, where you're focusing on operations and you don't really have control of whether it's impacting the strategy, or you come top down and focus only on strategy, but you can't make things happen. You've got to tie those two things together.
>
> ... Southwest Airlines has developed an approach that has made it the industry leader. They're leading on price, using a limited inventory of common airplanes and focusing on fast turnaround to reduce the number of planes required [and increase return on capital]. They had the strategy at the top, but the problem they had was how to get the organization aligned around it. The strategy itself would create the benefits by getting focused on one kind of airplane - a decision that can only be made at the top. But to ultimately execute the strategy on a permanent basis, they had to take this down to their employees.
>
> Today the culture at Southwest is one of empowerment. People learn to make decisions and take actions on their own without having to ask permission. They started with a major program of educating their work force on what the strategy was, what the key measures in the strategy were and what those measures meant. What is return on investment? What is cost per seat mile? Most importantly, what can you, one of 20,000 employees, do about it? They moved from the strategy at the top to bringing this down to every employee in the organization, investing heavily in education and communication programs to create that kind of alignment. Every stewardess, gate agent and baggage handler understands the strategy and the role they play in

[1] Nolan is one of the developers of the balanced scorecard, the other one is Robert Kaplan [73, 72, 71, 70].

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it.

8.2.4 Building the Balanced Scorecard

The final stage in building a balanced scorecard, will be to add establish the explicit connection between a strategy map to firm specific objectives, measures, targets, and initiatives. Figure 8.3 shows the strategy map described in section 8.2.3, as well as the objectives, measures, and targets for the internal perspective of Southwest.

As you can see in the case of Southwest, the objective for the internal perspective, i.e., the firm's statements in terms of what the firm hopes to achieve, is to achieve fast turnaround. The objective needs to be translated into measurable objectives, i.e, how we will determine success in achieving the objective. In their case they chose to use the following two metrics: The time an airplane has to state at the gate, and percentage of on-time departures. These measure need to linked to explicit targets. Typically, a target reflects a goal that the firm will want to achieve. In the case of Southwest the goal for the first of the measures is 30 minutes or less and for the second 90% or above.

Finally, the managers of the firm need to develop initiatives, i.e., plans of action that will help the firm achieve its target. For example, in the case of Southwest these are programs that could help employees to reduce the time it takes to serve an airplane at the gate. They could achieve this by analyzing historical data in order to identify factors that explain the amount of time it takes to serve an airplane, and the development of training programs that could help employees mitigate factors that lead to delays or exploit factors that reduce turnaround time.

8.3 IT Balanced Scorecard

The original success of the balanced scorecard, as well as the fact that its aim was to make the firm's strategic priorities and objectives understood by everyone in the organization, has led to the development of numerous departmental and/or business unit specific variations of the balanced scorecard. In the late nineties, firms started generating IT specific balanced scorecards. An IT specific balanced scorecard may be for the IT organization, specific IT initiatives, or just the implementation and/or use of large IT initiatives such as an ERP adoption.

Most IT organizations develop an IT balanced scorecard because they hope to achieve the following objectives:

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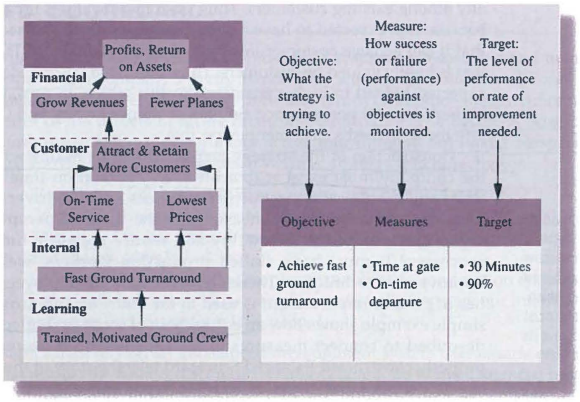
Exhibit 9-1
Illustrative Example for Lowcost Airline



measures
Descriptions of how success in achieving Balanced Scorecard objectives will be determined.

to give complete clarity to the objective. Measures describe how success in achieving an objective will be determined. Measures provide specificity and reduce the ambiguity that is inherent in word statements. Take, for example, Lowcost's internal objective to reduce ground turnaround time. How will this be measured: by the time elapsed from the time the plane lands until it takes off; by the time spent at the gate; by the time between the last arriving passenger leaving the plane until the boarding of the first departing passenger? Only by specifying exactly how an objective is measured will employees have a clear focus for their improvement efforts. Lowcost Airlines has chosen to measure the time spent at the gate but to eliminate the time, noncontrollable by employees, due to ground traffic congestion at the airport. The measure includes the time it takes to get passengers off the plane once at the gate; to get them boarded and seated; and for them to wait for departure, all actions that employees can influence. Lowcost also uses a measure of on-time departures so that employees understand why they must work hard to reduce ground turnaround time.

target
The level of performance or rate of improvement required for a Balanced Scorecard measure.

Once the objectives have been translated into measures, managers select targets for each measure. A target establishes the level of performance or rate of improvement required for a measure. Targets should be set to represent excellent performance, much like the par scores on a golf course. The targets, if achieved, should position the company as one of the best performers in its industry. Even more important would be to choose targets that create distinctive value for customers and shareholders. Lowcost has chosen 30 minutes at the gate and 90% on-time departures as its targets for its "fast ground turnaround" internal measures. These values represent best-in-industry performance.

initiatives
Short-term programs and action plans that will help the organization achieve the targets established for Balanced Scorecard measures.

In addition, managers identify initiatives, the short-term programs and action plans that will help the company achieve the stretch targets established for its measures. Lowcost Airlines has asked employees to develop continuous improvement and quality programs that will reduce the time that an airplane spends at the gate. Defects—instances when planes had to stay at the gate far longer than the targeted value (30 minutes)—are studied in detail to discover the causes. Project teams then develop process improvements, training programs, and actions that will eliminate the causes for long gate delays.

Figure 8.3: Southwest - Strategy Map & Balanced Scorecard (Source: Atkinson et al. 2004)

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1. Use it to align the firm's business strategy with IT strategy and operations. Because the main principle behind that balanced scorecard is that every action should be linked to the firm's strategic goals, it encourages a strategic approach to IT related decision making. It can help the firm select IT initiatives which are aligned with the firm's strategic priorities, and eliminate projects that are not adding value.
2. Evaluate and communicate the performance of the IT Organization to business managers. Given the fact that the financial effects of IT initiatives are indirect and/or intangible, firms use the IT balance scorecard to make visible the path through which IT affects financial performance.
3. Related IT organization performance to employee performance and compensation.

8.3.1 Balanced Scorecard for the IT Organization

One of challenges associated with the creation of the balanced scorecard is that for a lot of firms IT is treated as a utility and the mind set of the members of the IT organization tends to be reactive (i.e., putting out fires) rather than strategic [88]. Therefore, the first step towards the development of the IT balanced scorecard should be an attempt to develop a set of strategic goals for the IT organization. Obviously these goals should depend on the role of IT (IT strategy) of the organization. While the reactive mindset may be appropriate for a firm in support mode, it is not suitable for a firm in any of the other three modes in McFarlan's strategic grid.

One of the key difference when you develop a balanced scorecard for the IT organization, instead of the entire firm, is that the customer perspective focuses on IT users within the company, rather than external consumers. This by extension means that when we consider the financial perspective, we focus on the firm's top management team rather than shareholders [159]. Therefore the four perspectives of the balanced scorecard for the IT organization are as follows:

- Corporate perspective
- User perspective
- Internal process perspective
- Learning and growth perspective

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Corporate perspective

Corporate perspective refers to the business value of IT and the stakeholders are the firm's top management team. From their standpoint, their main concern is whether the IT organization accomplishes its goals and contribute value to the firm. An objective that relates to this concerns would be to raise the reputation and profile of the IT organization within the firm's top management team.

Van Grembergen and Van Bruggen [159] recommend that when it comes to evaluating the corporate contribution of the IT organization or IT initiatives, one could make the distinction between short term and long term contribution. Focusing on control of IT spending is a short-term contribution, however, the evaluation of business value of a new large IT initiative is a long-term analysis and contribution.

Given the escalating cost of IT spending [47], containing the IT budget is a common short term financial objective for many firms. Therefore, an IT budget expressed as a percentage of sales or per employee is a useful metric, which can be compared against either internal or external targets. For example, as shown in Figure 8.4, Intel follows the IT percentage of sales and the IT spending per employee to show that the firm has been able to contain its IT spending [23].

Other firms may compare their corresponding measures versus industry averages generated by consulting firms (e.g., Garter, Computer Economics) or magazine generated surveys like InformationWeek 500. Obviously, comparisons versus industry averages should take into consideration firm specific attributes, such as IT strategy and level of IT capability.

Especially for firms in strategic mode, it is very important that the firm invests in value adding IT initiatives. While it is tempting to rely on traditional financial tools such as ROI, NPV, and payback period (see Chapter 7), it is very important to keep in mind that these metrics are not likely to capture intangible benefits or the flexibility option that an investment in an infrastructure type of IT investment may offer. Implementing an IT portfolio management type of approach allows the management of the firm to consider the multidimensional aspects of new IT initiatives (e.g., financial benefits, business benefits, IT architecture, as well as business and IT risk).

User perspective

The firm's ability to contain IT spending and extract value from its existing as well as new IT initiatives will depend on the firm's IT capability. As we

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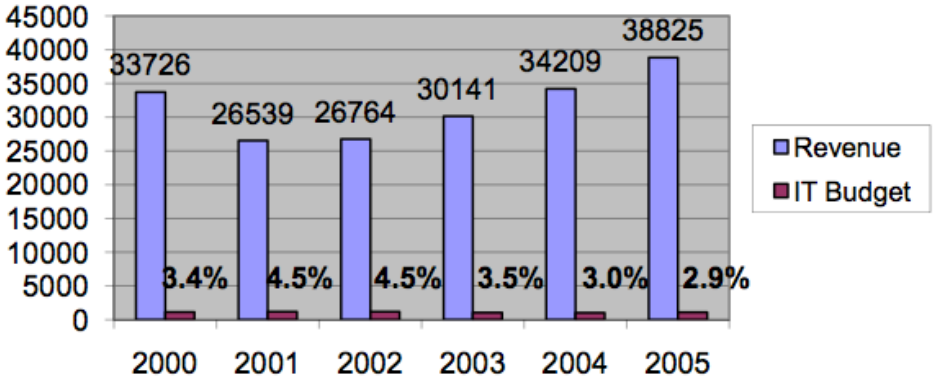

Figure 8.4: Intel - IT Budget. Source: Curley [23]

have seen in chapter 3 (p. 103) a firm's ability to implement IT initiatives and the ability of employees to extract value are two very important components of the firm's IT capability. While the importance of users in the latter is obvious, a second careful reading of the finding of the Standish Group (pp. 95-**??**) would convince you for the former too. If users are involved in the implementation of IT initiatives, the likelihood of successful implementation increases (therefore the IT spending may be lower), and the ability of users to extract value is increasing (therefore the new IT initiatives will be value adding).

Therefore, it is logical that the 'customer' perspective will be the driver behind the corporate contribution metrics. This means that the IT organization could hope to become the preferred supplier by users for applications and operations; develop a partnership with the users, and maximize the user satisfaction [159]. Recall that in the case of the IT organization, customers are all end users, as well as the firm's customer, if they are interacting with the firm's systems.

Van Grembergen and Van Bruggen [159] recommend the following metrics for each one of the user related objectives:

- Preferred IT supplier
  1. Percentage of applications managed by the IT organization.
  2. Percentage of applications delivered by the IT organization
  3. Percentage of in-house applications.
- Partnership with Users

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1. Index of user involvement in generating new strategic applications.
2. Index of user involvement in developing applications.

- User Satisfaction
  1. Index of user friendliness of IT applications.
  2. Index of user satisfactions with IT organization.
  3. Index of functionality of IT applications

The targeted percentages of the applications that are managed and delivered by the IT organization will depend on the firm's IT strategy (especially its outsourcing strategy). The target for survey based satisfactions indexes can be internal (i.e., improvement over time) or versus appropriate industry benchmarks. Figure 8.5 shows customer (user) satisfaction with the IT organization at Intel.

Figure 8.5: Intel - Customer Satisfaction. Source: Curley [23]

Internal process perspective

What are the drivers that could increase the way users feel about the IT organization? What could increase their level of trust, desire to partner with the IT organization in generation and development of new IT solutions, and

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their overall satisfaction with IT? The causality points back to the IT organization and its ability to deliver high quality IT services (effectiveness) and do this at the lowest possible cost (efficiency). According to Van Grembergen and Van Bruggen [159] this can be achieved if the IT organization can optimize its internal processes.

What kind of metrics should the IT organization adopt in order to gauge its internal processes. The aim should be to generate metrics related the management of IT operations and new IT initiatives (see discussion on operational and strategic component of IT budgets on p. 253). At the operational level, metrics should focus on such areas as the availability of existing systems and tech support the users. At the strategic level (new IT initiatives), the focus should be on successful implementation and training of users. The following list provides some representative metrics for each one of these areas [97, 7, 159]:

- Operational (support and maintenance) efficiency and effectiveness
  1. Number of user requests handled by IT help desk.
  2. Average time required to address a user requests or problems.
  3. Percentage of solutions within service level agreement (SLA).
- Efficiency and effectiveness in new IT investments
  1. Percentage of IT projects completed on time and on budget.
  2. Percentage of IT solutions released to users by the agreed upon date.
  3. Percentage of users that have been trained prior to release date.
  4. Satisfaction with training
  5. Percentage of resources dedicated to planning and review of IT processes and activities.
  6. Percentage of resources dedicated to new IT applications and initiatives.

The targets can be either internally generated (i.e., follow these measures over time) or external (i.e., compared to industry standards). The measurement and evaluation of these metrics could lead to useful information about the productivity of different resources, i.e., performance of specific people and technologies on specific projects [97]. It could force managers to evaluate their decisions and approach of dealing with allocation of limited resources [97, 7].

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Learning and growth perspective

Continuing with our cause and effect approach, we probe the final question regarding drivers that could explain the effectiveness and efficiency of the internal processes of the firm's IT organization. Obviously, the current state of internal processes reflects acquisition of resources and development of capabilities that the firm has made in the past. As a result the objective could be that of continuously improving the portfolio of a firm's IT applications, and prepare the firm for new disruptive technologies [97].

Metrics that have been recommended aim to capture a firm's focus in the following areas: training/education and expertise of IT employees, the state of portfolio of IT applications, and research on new and emerging technologies. The following list includes some of the most common metrics for the learning and growth perspective [97, 159]:

- Development of human IT capability.
    1. Percent of IT budget allocated to education of IT staff.
    2. Expertise of IT staff with existing and emerging technologies.
    3. Age distribution of IT staff.
    4. Turnover of IT employees.
- Ability of portfolio of IT applications to cover current and future needs.
    1. Age distribution of IT applications (hardware and software).
    2. Technical performance of portfolio of IT applications.
    3. User satisfaction with performance and functionality of portfolio of IT applications.
- Research into new technological solutions.
    1. Percent of IT budget allocated on research.
    2. Satisfaction of senior executives with plans and efforts to explore and exploit suitable emerging technologies.

Given the nature of these metrics the corresponding targets can be internal (performance over time) or external (benchmark versus industry average or best practices). These targets should be tied to specific initiatives undertaken by management and employees. For example, a high turnover rate may be associated with frustrated IT employees trying to support users who rely in an outdated legacy system.

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IT Balanced Scorecard: Concluding Remarks

The success of an IT balanced scorecard will depend on several factors. First, the firm's management and employees will have to buy in. Second, the metrics will have to be well selected and relatively small in number. Third, the targets must be realistic and gradually increasing (introduce a reasonable increase each year). Fourth, the employees should be able to see how their actions could affect the metrics and help them achieve their target. If the causality is clear, employees should be able to see how their actions help their firm achieve its strategic objectives.

8.3.2 An ERP Balanced Scorecard

As we have seen in Chapter 6 a firm's decision to invest or update an ES in one of the largest and most complex IT initiatives that a firm will undertake. Given the sheer magnitude of the implementation cost, the wide spectrum of tangible and intangible benefits associated with its adoption, and the multitude of business processes and organizations that will be affected, it makes sense that one should monitor carefully all stages of this investment.

It makes sense, and numerous firms have done this, to develop a balanced scorecard for the entire ES initiative or break it down into two stages. First monitor the implementation with an ES implementation balanced scorecard and then follow up with a balanced scorecard that monitors the use of the new ES. The former is motivated by the high percentage of firms that experience problems during their implementation. The objective could be as simple as that of achieving an implementation of the new system which is on time, on budget, and with the desired functionality. The latter should focus on the ability of users to extract value from the new systems.

In Chapter 7 we have seen that the result of an NPV analysis will depend on the cash inflows and outflows associated with evaluated project. An ES implementation that last longer than expected is bound to cost more, thus reducing the NPV of the investment. Developing an ES implementation balance scorecard will force managers to identify specific metrics that could be used to gauge the success of the project.

Deviations from targeted values, could be translated into higher implementation cost, which is reducing the NPV of the project. An implementation that lasts longer than expected, even if we assume that it did not affect the implementation cost, could postpone the expected benefits, and reduce their present value. Developing a balanced scorecard for ERP implementation will introduce an element of accountability, help managers take

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corrective actions, and ensure that the actual value of the projects stays as close as possible to the expected one (i.e., the NPV of the project).

Successful implementation of an ES does not guarantee that it will produce all desired benefits. The NPV of a project is based on assumptions and recommendation of managers who championed the investment in the ES. In the case of BlueBikes (p. 200) the management of the company had generated the following expected benefits:

> ... The management of BlueBikes estimated that the ES adoption would generate the following benefits: First, the firm's profit margin would increase from its current level of 50% to 60%. Second, availability would increase from 90% to 99%. Third, the firm could reduce its Days Sales Inventory by 10 days. The company hopes to convert 70% of the increase in availability in sales. BlueBikes users will be able to attain 60% of the increase in availability as well as reduction in inventory in the first year, and the remaining 40% in the second year.

Development of a balanced scorecard for ES use, could consider these expectations as targets. Any undesirable deviation of metrics on availability, conversion rate, and DSI from the targeted level would reduce the NPV of the project. Therefore, it makes sense that the management team that developed these expected benefits should monitor the balanced scorecard for ES use and be responsible/accountable for taking corrective actions or suggesting initiatives that could improve these metrics.

8.4 Summary and Concluding Remarks

The objective of this chapter was to re-enforce the concept of causality in the context of evaluation and monitoring of payoffs from IT investment. We have used causality in Chapter 1, as part of the DuPont analysis, and in Chapter 3, for the creation of synthesis table (p. 103). In this chapter we have seen how causality is used in the creation of the balanced scorecard, whether it is for the entire company, for the IT organization, or for specific IT investments.

There are numerous benefits associated with this cause and effect approach in management, as well as with the ability to relate strategy to measurable objectives. In order to emphasize the risk associated with the lack of monitoring system on a firm's IT budget, Gold [51] outlines the following sequence of events in a typical multi-business unit organization:

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1. Fierce competition among business units for scarce IT resources to achieve business unit strategy, leading to:

2. Dissatisfaction with the ITO when constrained resources result in project delays, leading to:

3. Blaming the ITO for lackluster business unit performance, justifying: The deliberate or unauthorized decentralization of IT functions ("ghost" IT spending, such as a business unit buying its own hardware and software), which results in:

4. Higher technology costs from ... uncoordinated efforts

8.5 Practice Questions and Problems

8.5.1 Study Questions

1. The following questions are based on the Whirlpool (WHR) Case [131].
   (a) Develop a business strategy map - for the WHR in general
      i. Based on the case, develop strategic objectives, performance metrics, and targets for the financial perspective of the company's balanced scorecard.
      ii. Based on the case, develop strategic objectives, performance metrics, and targets for the customer perspective of the company's balanced scorecard.
   (b) Develop a business strategy map related to the implementation of ERP at WHR
      i. Based on the case, develop strategic objectives, performance metrics, and targets for the financial perspective of the ERP balanced scorecard.
      ii. Based on the case, develop strategic objectives, performance metrics, and targets for the user/customer perspective of the ERP balanced scorecard.
      iii. Based on the case, develop strategic objectives, performance metrics, and targets for the internal process perspective of the ERP balanced scorecard.
      iv. Based on the case, develop strategic objectives, performance metrics, and targets for the learning and growth perspective of the ERP balanced scorecard.
2. Incorporate the implementation of ERP at WHR as part of the company's overall strategy map.

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3. Identify key differences between the ERP balanced scorecard for WHR and the corresponding balanced scorecard for a firm that implements a cloud based version of ES.
4. Relying on described expected benefits from ES implementation at BlueBikes (see p. 200), suggest a balanced scorecard that focuses on ERP use.
5. Create the strategy map and outline the key components of the balanced scorecard of the IT organization that relies heavily on outsourcing.
6. Generate objectives, metrics, and targets for the customer perspective of the strategy map shown in Figure 8.3.
7. Describe the business model and outline the strategy map for a company of your choice.

8.5.2 Multiple Choice Questions

1. In an input-process-output causality model, IT outputs can be classified as either internal or external. The following is NOT an internal output.
   (a) improved product quality
   (b) increased capacity utilization
   (c) customer loyalty
   (d) time saving in production
2. In a typical multi business unit (BU) organization it is likely that we will have the following chain of events: "Competition among BUs for scarce IT resources leads to dissatisfaction with the IT organization when constrained resources result in project delays, leading to blaming the IT organization for lackluster BU performance, which is used to justify deliberate or unauthorized decentralization of IT functions ('ghost' IT spending, BU buy their own H/W and S/W)."
   (a) It is likely that this will result in higher technology costs but we don't know why.
   (b) It is likely that this will result in higher technology costs from lower bargaining power with H/W and S/W vendors.
   (c) It is likely that this will result in higher technology costs from lost economies of scale.
   (d) It is likely that this will result in higher technology costs from lost economies of scale and lower bargaining power with H/W and S/W vendors.

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3. What are the typical steps involved in building a Balanced Scorecard?
   (a) Strategic objectives to Metrics to Finance to Strategy
   (b) Strategic objectives to Metrics to Targets to Initiatives
   (c) Strategy to Financial Performance to Strategic objectives to Targets
   (d) Financial Performance to Targets to Metrics to Strategic objectives

4. The typical balanced score card will include four quadrants capturing different performance related aspects. Measures reflecting a company's ability to sustain its competitive advantage will be in the ... quadrant.
   (a) Financial
   (b) Learning and Growth
   (c) Internal processes
   (d) Customer

5. Establishing cause and effect relationships (leading and lagging elements) between drivers of IT success is critical in an IT contribution model. The following is an example of such leading and lagging elements:
   (a) higher customer satisfaction ⇒ Increased IT resources ⇒ Increased delivery options to ⇒ more sales
   (b) Increased delivery options ⇒ higher customer satisfaction ⇒ Increased IT resources ⇒ more sales
   (c) more sales ⇒ higher customer satisfaction ⇒ Increased IT resources ⇒ Increased delivery options
   (d) Increased IT resources ⇒ Increased delivery options ⇒ higher customer satisfaction ⇒ more sales

8.6 Business Analytics Practice Problems

8.6.1 Monitor Risk of ERP Project - 1

Leverage the information from the risk analysis of the Whirlpool ERP implementation - see section 7.8.1 (p. 223) - to suggest a two-part balanced scorecard.

The first part will be used to monitor the progress during implementation (focus on implementation cost) and the second one for after implementation (focus on operational costs and benefits).

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8.6.2 Monitor Risk of ERP Project - 2

S&B Corporation is the aircraft engine industry.[2] The company designs, manufactures, repairs and services aircraft engines and sells spare parts to airlines. The company has manufacturing facilities in North America and engine service depots in Southeast Asia, Europe and North America. The company is known as one of the most reliable provider for aircraft engine repair and manufacturing. S&B realizes that airlines need to have the engines serviced and returned to them as soon as possible and tries to do this by making sure that there are always parts available for engine repairs in the service depot that they are needed.

After 9/11 the airline industry was hit very hard and S&B felt the effect too. In the beginning of 2002, the company embarked on an enterprise wide cost cutting to improve its financial performance and in order to respond to the changes in the airline industry. More and more of the airlines were looking for providers that were not only reliable but also could do this at the lowest possible cost. The company had to maintain its reputation as the most reliable service provider while they were cutting costs.

One of the first decisions was to replace all the 1000 old and loosely connected legacy operating systems and a host of homegrown applications with one integrated system. The company chose SAP and plan to start implementation with the core financial system. General ledger, cost controlling, fixed assets, A/P, and A/R were implemented globally. They will continued with Production, Materials and Project management, and Human Resources ERP components. With the production, materials and project management they will be able to handle various aspects of production such as demand forecasting, production scheduling, job cost accounting and quality control. The Human Resources component will be used for payroll, benefits, compensation, and performance assessment.

To allow for the unique characteristics and processes that different business units were using the need for ERP customization arose. For example the production, materials and project management component allowed links with external suppliers over the Internet. A key feature of the process used in the repair facilities is that the supplier cannot ship a part until the shipping label was printed and supplier cannot print the label until the assembly team was ready to receive the material at the service depot. Another uniqueness in the S&B processes had to do with the spare parts. A part that has been allocated for new engine production in the warehouse should be redirected if it is needed for engine repair. To accommodate for several such

[2]The outline of this mini-case is based on Chand et al. [13].

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unique processes customization of production, materials and project management components of the ERP system at the country/business unit level were necessary.

The ERP system will help S&B streamline business processes by linking cross-functional processes, reducing error rates, increasing information visibility, and providing S&B with the infrastructure that is allowing it to better meet and accommodate new requirements and challenges.

The estimated cost of the ERP project will be close to 400 million dollars. Naturally, the board of S&B wants to make sure that the company will be able to contain the implementation cost and enjoy the payoffs from such an investment. As part of the consulting group that advises the board of directors at S&B, your job is to assist with the development of an ERP balanced scorecard. Please complete the following tasks:

1. Develop a business strategy map related to the implementation of ERP at S&B.
2. Based on the S&B case, develop strategic objectives, performance metrics, and targets for the financial perspective of the ERP balanced scorecard.
3. Based on the S&B case, develop strategic objectives, performance metrics, and targets for the user/customer perspective of the ERP balanced scorecard.
4. Based on the S&B case, develop strategic objectives, performance metrics, and targets for the internal process perspective of the ERP balanced scorecard.
5. Based on the S&B case, develop strategic objectives, performance metrics, and targets for the learning and growth perspective of the ERP balanced scorecard.

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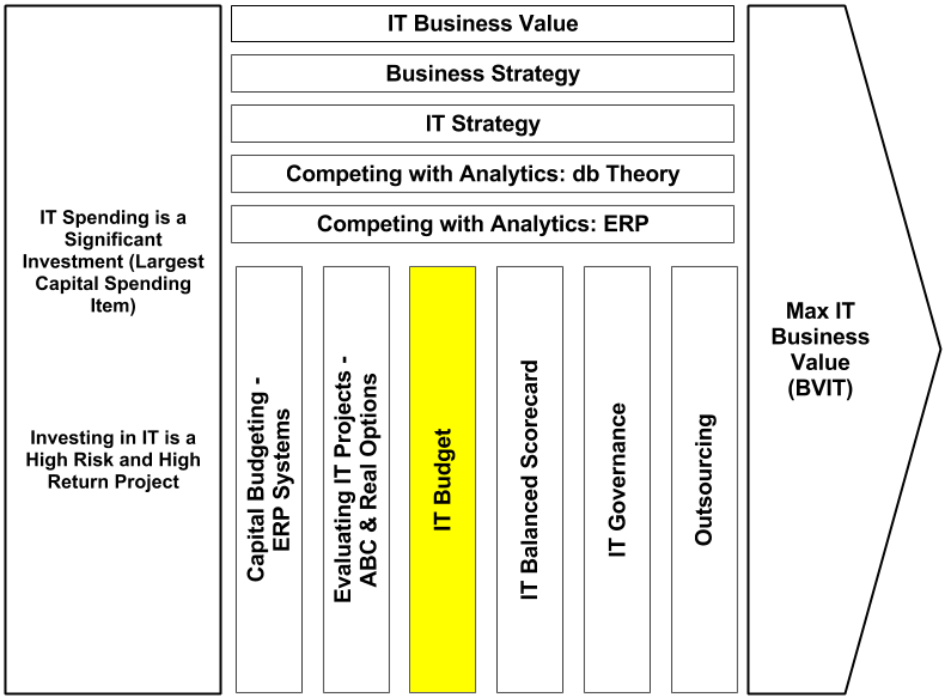
Chapter 9

IT budgets & IT Portfolio Management

If you can keep your head when all about you
Are losing theirs and blaming it on you ... (If ... by Rudyard Kipling)



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Learning Objectives

By the end of this chapter you should be able to understand and apply the following concepts:

- IT budgets and IT budgeting process
- CFO's versus CIO's view of IT budget, and cost allocation
- IT spending in accounting standards
- Environmental factors and IT budget levels
- Internal factors and IT budget levels
- Technological factors and IT budget levels
- IT portfolio management
- Steps in IT portfolio management
- Process for evaluation of IT projects
- Strategic versus operational risk
- Risk analysis of new projects

9.1 Introduction

According to a 2011 global business technology survey by McKinsey [128] "[a]spirations-and current expectations-for IT have never been higher. Executives continue to set exacting demands for IT support of business processes, and they see an even larger role for IT in a competitive environment increasingly shaken up by technology disruptions. ... Looking ahead, executives expect IT to create new platforms to support innovation and growth, help guide strategy with data and advanced analytics, and stay on top of possible new roles for mobile devices."

One of the implications of this survey is that senior executives are willing to spend more on IT initiatives. Higher IT spending elevates the need to focus on the management of IT resources (IT budgets) and makes it more likely that at any given time, the firm's management deals with a portfolio of IT investments. This means that senior executives assigned with decision rights for the funding IT initiatives, must evaluate the likelihood that these IT investments will produce the expected rate of return. If the executives approve the funding of these IT investments, they implicitly indicate their approval to the process and assumptions made for the estimation of the expected costs and expected benefits.

Recognizing that a firm deals with a portfolio of IT investments conditions managers to go beyond approving the funds for IT projects. Besides looking at the expected benefits and expected costs, like investors they must

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also look at the risk of these projects. In this chapter we are going to cover two integrated topics: IT budgets and IT portfolio management.

In Chapter 3, we approached IT strategy from a conceptual standpoint, as the shared view among a firm's top management team (TMT) regarding the role of IT in the organization. The firm's IT budget will depend on TMT's understanding and view of the role of IT in the firm. Approaching IT strategy in terms of the expected results, we see that it has a two-pronged objective. First to explore IT related opportunities for creating value. This includes identification and prioritization of IT initiatives, and their successful implementation. The second objective is to make sure that the users can extract value from these IT initiatives. That is monitoring the realized payoffs of these IT initiatives, to make sure that they deliver the expected benefits over the lifetime of these projects.

In the rest of the chapter, we are going to explore the following topics. First, we are going start with a general introduction on corporate budgets, contrast accounting versus IT managers' views on the IT budget. Second, we are going to explore and compare rules and guidelines regarding IT spending between US - Generally Accepted Accounting Principles (US GAAP) and International Financial Reporting Standards (IFRS). Third, we are going to explore the role of internal and external factors on the level of IT spending, and consider the issue of allocating IT cost. Fourth, we are going to introduce the IT portfolio management as a holistic approach for dealing with IT initiatives.

9.2 Corporate and IT Budget

Budgets reflect how organizations allocate financial resources to different units, based on the planned activities and the short term objectives of each unit. The typical budgeting process starts in the fall (or several months before the end of the firm's fiscal year). Organizational units are asked to provide the following information: forecast the level of sales or the level of services that they will provide for the next period, typically next year, as well as various short-term and long-term expenditures needed to support the projected level of sales. This is the time, when the different units will present their requests for funding of new projects/services. Given the ubiquitous role of IT in business processes, for many companies, the majority of requests for new spending tend to be associated with IT initiatives.

Projections and requests for funding are evaluated by senior finance managers, and after several rounds of iterations the budget is established. There

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are several pros and cons associated with budgets. Through the budgeting process, firms allocate limited resources to different units and evaluate those units by some comparison of actual versus budgeted results. When used properly, budgets provide a way of communicating the firm's short-term financial goals to its members. Budgets can help senior executives coordinate the many activities of an organization, and maintain control over multiple divisions and business units. On the other hand, rigid adherence to an annual plan that is set in stone is likely to stifle innovation and limit agility, i.e., the firm's ability to respond to dynamic competitive environment.[1]

Given the fact that 'needs' tend to be more than available resources, the budgeting process is bound to generate some tension between the accounting side, who are seen as the 'bankers,' and the different organizational units. These tensions are quite evident when it comes to funding the IT organization and the firm's IT initiatives. While the opening news story points to the opportunity for a synergistic relationship between the firm's finance and technology executives, a recent article in the CFO magazine, describes the relationship between the CFO and CIO schizophrenic [22].

Cramm [22] argues that while a productive CIO-CFO relationship is critical to the successful exploitation of technology, CIOs find the relationship difficult and frustrating to navigate. One of the root causes of the frustration stems from the fact that when it comes to IT, CFOs serve multiple and often conflicting roles: CFO's are IT's business partner, banker, and in some cases, boss. *This means that in a given work week, it's not unusual for CFOs to request additional IT support, cut the IT budget, and criticize the CIO's progress in strengthening the company's competitive position.*

It has been suggested that the root of this problems rests on the fact that accounting and IT professional approach IT budget from different angles [103, 141]. Accounting and finance managers tend to think in terms of fiscal budgets, while technology managers tend to think in terms of functional budgets. Understanding the factors that contribute to the difficulty of establishing a more productive relationship between the accounting and technology side is very important.

[1] Budgets and the budgeting process are covered in more detail in managerial accounting classes. For a brief review of budgets and budgeting process see Hope and Fraser [65].

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In the following sections; we will try to understand these differences. We will start by defining an IT budget, describing its components, and exploring IT budgets and IT spending from an accounting standpoint.

9.3 IT Budget

IT Budget: Definitions

In order to define IT budget/spending we are going to examine and consider explicit or implicit feedback provided by IT related consulting firms and media. IT consulting firms tend to generate reports for their clients that contain some definition of IT budget/spending. For several years, Gartner (one of the major IT research and consulting firms) has been running a survey on IT budgets. In their instructions to business managers who participate in their surveys and readers of their reports, they provide detailed descriptions in terms of what constitutes IT spending and it is part of an IT budget. For example, in two of their recent reports [124, 46], they define IT budgets/spending as follows:

> "... The best estimate of total spending at the end of the 12-month budget period for IT to support the enterprise. IT budget/spending can come from anywhere in the enterprise that incurs IT costs, and it is not limited to the IT organization. It is calculated on an annualized 'cash out' basis, and, therefore, contains capital spending and operational expenses, but not depreciation or amortization."

InformationWeek has been collecting information about IT budgets, as part of the InformationWeek 500 (IW500) report, since the late eighties. The question on IT budget tends to have a brief description of what constitutes IT spending and it should be considered as part of a firm's IT budget. For example the questionnaires for the last five years (2009-2013) of the IW500 report contained the following instructions:

> "... The budget figure should include capital and operating expenses for infrastructure, including telecom, networking and hardware; applications (maintenance and development and packaged); Internet-based costs; salaries and recruitment; IT services/outsourcing; and training."

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IT Budget: Elements

While these definitions provide us with a general understanding of IT budgets, they are a bit general. They don't tell us the specific elements of an IT budget. Approaching IT budgets from a resource or cost perspective, Gartner suggest that IT spending should include hardware, software, personnel, outsourcing, disaster recovery, and occupancy costs associated with supporting IT within the entire company [124, 46].

Hardware includes all current equipment costs plus any planned hardware purchase, as well as maintenance fees. Hardware refers to client and enterprise computing, document management, and network infrastructure. The typical hardware category of an IT budget will include items from the following list: Computers, laptops, servers, firewalls, hubs, routers, cabling, printers, and scanners [86, 52].[2]

Software includes all current software costs plus any planned software purchases, as well as support and maintenance fees for infrastructure software and applications. The category includes such items as software for servers, laptops, and desktops, as well as anti virus, and backup software [86, 52].

IT personnel includes development, production/operations, administrative, IT management personnel, IT-related human resources (benefits, travel, training, recruitment), as well as non-employees who perform IT tasks under contract, typically on site [124, 46, 52].

Outsourcing includes costs associated with external IT services (e.g., AaaS, desktops as a service, hosted email), consulting, system integration, data and voice transmission.

Disaster recovery includes all costs associated with backup, disaster recovery, and business continuity systems. Typical components of this category include software, hardware, co-location, outsourced backup, and licenses [86, 52]

Occupancy costs refer to the cost of facilities being used by the IT organization. This category includes such items as office space, furniture, electricity, maintenance, property taxes, security and office supplies. However, this category does not include costs for space dedicated to IT functions, such as a data center [124, 46].

Alternatively, the elements of an IT budget can be seen from an IT domain or activity perspective. This kind of categorization includes the following elements [124, 46]:

[2] "... Industry standards suggest that computers and laptops should be replaced every three years and that servers should be replaced approximately every five years." [86]

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> "... The data center (e.g., mainframes, servers and storage), client devices (e.g., desktops, laptops, PDAs, smartphones), voice and data networks (including, but not limited to, voice and data transmissions, fixed and mobile telephony, and Internet access services), IT help desk, and applications (development and maintenance).
>
> IT support functions, such as the office of the CIO; supervisory management; finance and administrative costs, such as purchasing; asset management; process management; and marketing of IT services.
>
> Dedicated data processing equipment used in operations, production and engineering environments — examples are computer-aided design/computer-aided manufacturing (CAD/CAM) and standard computing equipment used in devices for factory automation, and tablet PCs used by healthcare professionals."

IT Budget: Operational and Strategic

Perhaps the most common categorization of elements on an IT budget is in terms of operational and strategic, because IT managers tend to approach IT budgets from a functional standpoint (See SideNote Rethinking IT Budgets on p. 255). At the functional level, IT managers make the distinction between operational cost and strategic spending.

Over the years, consulting firms have generated variations of these two terms. For example, Gartner suggest that from a functional standpoint IT spending is used to run, grow, or transform the firm. Similarly, Deloitte & Touche suggests that IT spending can be used to keep the light on, advance the ball, or change the rules. Optimal Networks (an IT consulting firm) suggests that IT spending should be for support/maintenance or (planned new IT) projects.

Regardless of its name (i.e., operations costs, keep the light on, run maintenance, or support), an operational IT budget refers to IT spending that is needed to keep the organization operating. Examples of IT operations related budget items may include such costs as mission-critical server replacements, key software upgrades, and personnel costs associated with administering and maintaining the IT infrastructure on a day-to-day basis.

Variations of this description of an operational IT budget have been used by consulting firms. According to Garner [52]: "*... [T]he IT operating budget is made up of the operating expenses for enterprise IT. Implied in the word "enterprise" is the overhead IT expense budget and known business-unit IT*

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expenses (overhead or in operating budgets)." More specifically it includes the following categories: hardware, software, internal and external IT personnel, networking and telecommunications charges, and other expenses.

Optimal Networks define the operational IT budget (support/maintenance related IT spending) as follows [86]:

> "... [Support/Maintenance] refers to all costs related to the support and maintenance of your IT environment—your network and infrastructure. These are the ongoing expenses required to maintain your current environment and provide adequate helpdesk and user support. For most organizations, this includes the following: Salaries and benefits for all internal IT staff; Monthly support costs for external IT consultants; Annual support costs for any vendors of hardware and software you own; Training and education for internal IT staff to make sure they are kept informed about cutting edge IT for your industry; Data network including WAN connections, ISP links, VPN expenses; Outsourced services costs, including monitoring, patching, helpdesk, spam filtering, and any other managed services."

Similarly, strategic IT budget or strategic IT investments is know as IT spending to grow, transform, to advance the ball, change the rules, or simply as capital budgets and projects related IT spending. Strategic IT spending refers to new IT initiatives that aim to improve the firm's competitive position, hence their alignment to the organization's business and corporate strategy is a top priority. Strategic IT initiatives are likely to be undertaken when the firm's financial position is strong, and postponed when cash is tight. As a result their timing tends to correlate with the firm's cash flow. During the implementation stage strategic IT initiatives, tend to have a low impact on operations.

Gartner [52] provided the following definition of a capital budget:

> " ... Capital budgets represent expenditures that reoccur infrequently and are depreciated over a period of years to match their life cycle as useful assets. For example, large mainframes may be acquired only once every five years; construction of a new data center facility may occur once. As a result, growth rates of capital budgets are highly volatile for individual enterprises and industries. The expenditure of IT capital results in depreciation and amortization, which is added to the IT budget."

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SideNote: Rethinking IT Budgets - 1

Now afforded a more active role at the budgeting table, many CIOs feel immediate pressure to come up with better ways to plan and account for expenditures. ... One simple move that Rent-A-Center has made involves the designation of new IT initiatives as capital expenditures. The idea is to isolate and highlight funding for new projects, rather than lumping these investments in with operational expenditures. Rent-A-Center isn't alone. Many corporations are beginning to peel apart these two distinct budgeting subsets. ... Splitting apart the two main components of a technology budget is little more than a good first step, however. Prudent CIOs will also impose the use of pricing and other industry benchmarks to make sure they are getting the best deals possible.[a]

[a] 100.

Optimal Networks define the strategic IT budget (new project related IT spending) as follows [86]:

> " ... This category should include any projects planned for the coming year including any infrastructure updates like a transition to a full or hybrid cloud model, full workstation or server replacements, and other adjustments to your environment that do not happen every year. It should also include new equipment and software that require significant time and planning to implement and integrate. This category should include costs for: Project Planning; Project Implementation; New Equipment; New Software."

As mentioned above, consulting firms further divide strategic IT spending into grow or advance the ball versus transform or change the rules. Grow or advance the ball IT budget related items typically include such initiatives as the implementation of new software that makes operations more efficient, the purchase of a new firewall that provides additional protection from cyber threats or an upgrade of the organization's website that improves interactivity with customers [138]. Transform or change the rules budget items aim to identify right technologies for new organizational capabilities, fundamental changes to business processes, or new product or service offering [138].

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On average firms spend between 50 and 90 percent of their IT budget on operations. In IT capable firms like Harrah's (see page **??**) there is a continuous pressure to reduce the operations related costs. The CEO at Harrah's Resorts, Garry Loveman wants his CIO to cut the portion of the IT budget consumed by maintenance from 60% (until fairly recently it was at 80%) to 40% or less [37]. However, this is not always easy and risk free. Organizations that have to trim IT budgets should weight the operational risk associated with cutting operational costs. If an organization already is going through a tough stretch, the last thing it needs is a server, application or network failure [138].

9.4 Accounting View of IT Budget

Casual observation of the operational and strategic components of an IT budget, may lead to the conclusion that there is one to one mapping to operating and capital expenditures. However this is not the case. For example, by their very nature, IT strategic initiatives may include many different types of costs some of which are capitalized (capital expenses) while others are expensed (operating expenses). For example, according to Garner [52] " ... Organizations generally carry the acquisition costs of hardware and other capital investments over a period of years as an expense (if leased) or as a depreciation expense (if purchased) in an IT expense or operating budget ... ."

When the accounting department works on the IT budget, the focus is on two areas: capital expenditures and operating expenses. The general principle is that capital budgets are used to deal with long-term and/or large IT investments, while the operating budget covers the cost of running the firm's IT operations. While the typical examples of operating expenses in an IT budget include staff, training, voice and data lines, software maintenance, and hardware support, what expenses are allocated in the capital budget varies across firms.

Allocating expenses as capital or operating becomes a point of discontent between the accounting and technology executives. Technology executives would rather have a higher portion of their expenses capitalized because this makes their overall expenses smaller. On the other hand, accounting executives have to look at the big picture, and take into consideration such issues as earning targets and tax, in order to make their allocation. The final choice should be aligned with the CFO's or Controller's corporate financial strategy.

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Survey results have shown that some firms capitalize project development, infrastructure, consulting fees, and full-time staff, while others capitalize only major technology purchases [141]. However, the fact is that there is wide spectrum of different approaches used to handle IT spending and there is a 'wide degree of latitude allowed for IT costs under generally accepted accounting principles' [141]. IT professionals have pointed out that when it comes to IT expenditures, there are few accepted accounting principles [82]. In the following section, we will examine the role of IT spending in accounting standards.

9.4.1 IT Spending in Accounting Standards

The following discussion in based on the research project that Tiffany Chung completed under the supervision of Prof. Stratopoulos in Fall 2013. The objective of this project was to explore and compare rules and guidelines regarding IT spending between US - Generally Accepted Accounting Principles (US GAAP) and International Financial Reporting Standards (IFRS). The report starts with a general description of accounting standards, followed by research methodology, and summary and comparison of main results.

Accounting Standards

Generally Accepted Accounting Principles (GAAP) are typically developed by professional associations, and they are enforced by regulatory authorities. Collectively they form a framework that outlines the rules and guidelines for the financial reporting of companies operating within a specific jurisdiction (e.g., US or Canada). The main goal of these principles is to enhance transparency and allow users to compare results reported by different firms.

Over time, each nation developed its own set of GAAP, but as globalization increased there has been a need to establish a consistent language for financial reporting and a move towards the adoption of International Financial Reporting Standards (IFRS) worldwide. In particular, for reporting periods after January 1, 2011, all publicly-traded companies in Canada are required to use IFRS. Although US GAAP is still allowed in US, most multinational corporations have chosen to adopt IFRS in their operations, in order to reduce the administrative costs related to adhering to differing accounting standards worldwide.

While the fundamental objectives of the standards are similar, there are some underlying conceptual differences that should be taken into account. US GAAP is largely rules-based while IFRS is principles-based. This means

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that IFRS offers greater freedom and flexibility in its interpretation, so that companies can report their results in a way that most faithfully represents their economic position. IFRS, being the uniform global standard, also typically requires more extensive disclosure.

Given the fundamental differences between the accounting standards, it may be difficult to effectively compare the IT-related disclosure guidelines among the standards; reporting requirements are likely to vary in terms of content, as well as specificity.

Research Methodology

Since IT reporting is not enforced by securities regulators, there are no explicit requirements as to what to report in IFRS, but there are many guidelines for the reporting of technological investments implicitly embedded in the standards. On the other hand, there are a few sections explicitly detailing guidelines for the reporting of technology-related expenditures for internal use in US GAAP.

Our approach has been to mine data from IFRS and US GAAP for guidelines associated with the reporting of IT related spending. To accomplish our goal we have generated a list of key words based on our own experience and based on key words found in various reports [52, 86, 124].

We used these keywords to perform a comprehensive searche of IFRS and US GAAP. Each search result was manually filtered for relevance and sorted based on the significance and clarity of the standard. The following table summarizes the results from the search for IFRS, US GAAP. Note that these results may be disproportionately skewed to those searches attempted first, as repeated results were deemed irrelevant.[3]

Summary and Comparison of Results

IFRS focuses on topics such as classifying technology investments, also touching on the increasingly relevant topic of outsourcing. US GAAP covers more of the implementation aspect of IT, including the process of reengineering business processes and monitoring project completion. However, where IFRS and US GAAP explore the same topic, the standards tend to mirror each other (e.g. in relation to technological obsolescence and research and

[3]Other Search Terms: laptop, server, firewall, router, switches, cabling, routine hardware implementation, server software, laptop software, desktop software, anti-virus, anti-spam, backup software, routine software implementation, cloud services, colocation, outsourced backup

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Order	Keywords	IFRS Total	IFRS Relevant	US GAAP Total	US GAAP Relevant
1	information technology	28	6	43	7
2	accounting information	76	1	51	0
3	computer hardware	2	1	14	1
4	computer software	6	1	50	3
5	database	3	0	8	0
6	SCM system	2	0	1	0
7	CRM system	20	0	15	0
8	computer	7	0	59	0
9	proprietary technology	8	0	6	0
10	enterprise system	8	0	7	0

Table 9.1: IT in IFRS and US GAAP

development). US GAAP may provide additional detail in some respects, as it is rules-based. In addition, US GAAP more clearly distinguishes IT investments from general investments in technology. For example, section 350-40 defines accounting reporting requirements for software developed for internal use only (relevant to IT spending), whereas section 985 describes software developed for resale (irrelevant to IT spending). IFRS provides less clear guidance, so substantial professional judgment was used in making the distinction.

By and large, the search results for IT-related reporting requirements were closely linked to intangible assets, and in particular, software. However, due to the ambiguity of the principles-based IFRS, it was extremely difficult to accurately separate investments in technology in the ordinary course of business and IT-specific investments; substantial professional judgment was used in making this distinction. In US GAAP, sections 350-40 (Intangibles – Goodwill and Other: Internal-Use Software) and 720-45 (Other Expenses: Business and Technology Reengineering) were deemed to provide the most relevant guidance. Although not explicitly tied to IT, the scope and nature of these sections are sufficiently similar that it is prudent to categorize them as such.

Common Findings: Technological Obsolescence

Both IFRS and US GAAP take into consideration the fast pace of technological innovation and its effect on useful lives of IT assets such as hardware and

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software. Investments must be re-evaluated on an annual basis to account for the effects of obsolescence, technology, competition, and other economic factors. Therefore, companies will need to continuously make new investments in order to maintain and sustain their competitive advantages. In particular, companies will likely favour investments that are able to deliver high returns in a short period of time, given the substantial straight-line amortization that will likely be associated with technology assets on an annual basis.

> *IFRS Source – IAS 38 Intangible Assets*:
>
> Given the history of rapid changes in technology, computer software and many other intangible assets are susceptible to technological obsolescence. Therefore, it is likely that their useful life is short.
>
> *US GAAP Source – 350-40 Intangibles – Goodwill and Other: Internal-Use Software*:
>
> In determining and periodically reassessing the estimated useful life over which the costs incurred for internal-use computer software will be amortized, entities shall consider the effects of all of the following: a) Obsolescence; b) Technology; c) Competition; d) Other economic factors; e) Rapid changes that may be occurring in the development of software products, software operating systems, or computer hardware and whether management intends to replace any technologically inferior software or hardware. Given the history of rapid changes in technology, software often has had a relatively short useful life.

Common Findings: IT Research and Development

IFRS provides broad outlines (while US GAAP provides specific examples) of how to account for costs for internally generated assets, which includes IT-related developments – more specifically, whether or not they should be expensed or capitalized. Typically, costs should be expensed in the initial research phase, and capitalized in the development phase once the design and specifications of the project have been more clearly defined. From this, it can be extrapolated that for investments where the technology has already been proven and the firm is a follower, expenses associated with the investment are more likely to be capitalized, whereas if the firm is a leader of IT that is expected to actively engage in the development of technologies

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that will transform the operating environment of businesses in the industry, associated costs are more likely to be expensed.

> *IFRS Source – IAS 38 Intangible Assets*:
>
> In the research phase of an internal project, an entity cannot demonstrate that an intangible asset exists that will generate probable future economic benefits. Therefore, this expenditure is recognised as an expense when it is incurred. [...] In the development phase of an internal project, an entity can, in some instances, identify an intangible asset and demonstrate that the asset will generate probable future economic benefits. This is because the development phase of a project is further advanced than the research phase.
>
> *US GAAP Source – 350-40 Intangibles – Goodwill and Other: Internal-Use Software*:
>
> Internal and external costs incurred during the preliminary project stage shall be expensed as they are incurred. Internal and external costs incurred to develop internal-use computer software during the application development stage shall be capitalized. Costs to develop or obtain software that allows for access to or conversion of old data by new systems shall also be capitalized. Training costs are not internal-use software development costs and, if incurred during this stage, shall be expensed as incurred. Data conversion costs, except as noted in paragraph 350-40-25-3, shall be expensed as incurred. Internal and external training costs and maintenance costs during the post implementation-operation stage shall be expensed as incurred. In order for costs of specified upgrades and enhancements to internal-use computer software to be capitalized in accordance with paragraphs 350-40-25-8 through 25-10, it must be probable that those expenditures will result in additional functionality. Internal costs incurred for upgrades and enhancements shall be expensed or capitalized in accordance with paragraphs 350-40-25-1 through 25-6. Internal costs incurred for maintenance shall be expensed as incurred. Entities that cannot separate internal costs on a reasonably cost-effective basis between maintenance and relatively minor upgrades and enhancements shall expense such costs as incurred.

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IFRS-Specific Findings: Accounting Classification of IT

When determining how IT-related investments are to be classified, their importance to the system's ongoing functionality is the primary consideration. In other words, the underlying technological infrastructure of a company will more likely be treated as property, plant, and equipment, whereas auxiliary applications software will more likely be treated as intangible assets; furthermore, IT investments in the latter category may be grouped with other intangible assets if deemed insignificant.

> *IFRS Source – IAS 38 Intangible Assets*:
>
> In determining whether an asset that incorporates both intangible and tangible elements should be treated under IAS 16 Property, Plant and Equipment or as an intangible asset under this Standard, an entity uses judgement to assess which element is more significant. For example, computer software for a computer-controlled machine tool that cannot operate without that specific software is an integral part of the related hardware and it is treated as property, plant and equipment. The same applies to the operating system of a computer. When the software is not an integral part of the related hardware, computer software is treated as an intangible asset.

IFRS-Specific Findings: IT Outsourcing

The outsourcing of goods and services is also a key dimension in the realm of IT-related investments. IFRS states that companies may record outsourcing as a transfer of property, plant, and equipment, instead of a direct sale of equipment to the outsourcing provider, as was often done in the past; these guidelines are more consistent with current practices. In reality, the implications of this change in policy are limited as the positions of both parties are fundamentally unchanged; however, this does prevent the outsourcing provider from taking the company's original assets and using them to service their competitors.

> *IFRS Source – IFRIC Interpretation 18 Transfers of Assets from Customers*:
>
> Transfers of assets from customers may also occur in industries other than utilities. For example, an entity outsourcing its information technology functions may transfer its existing items of property, plant and equipment to the outsourcing provider.

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US GAAP-Specific Findings: Business Process Re-engineering

In terms of implementing IT investments, US GAAP only provides guidance on vanilla implementations – in other words, how to modify business processes to match newly-installed IT systems; there exists no provision for the modification of software. The standards assume two extremes: a vanilla implementation of external software or self-development of internal software, without regard for the company's IT capability. Therefore, most IT investments can be expected to make a transformational impact on the organization, given that they require a substantial change to either the entity's software or the entity's operations, with little middle ground.

> *US GAAP Source – 720-45 (Other Expenses: Business and Technology Re-engineering)*:
>
> Information technology transformation projects that involve software packages (sometimes called enterprise software) recently have been undertaken by entities that must reengineer their business processes to connect into that software rather than modify that software to connect into their existing business processes. The transformation project may include the installation of new computer hardware, the purchase of office equipment, furniture, or work stations, and the physical reconfiguration of the work area.

US GAAP-Specific Findings: Project Impairment

Consistent with McFarlan's studies, any project which is not completed on time, within budget, and fully functional is considered to be impaired, and must be reported at the lower of the carrying amount or fair value (less selling costs), which is expected to be zero or close to zero. This presents significant risks for companies who actively seek to be at the forefront of technology in their industry, as the consequences of failed internal developments are huge. It also explores the idea of competition and the limitations of self-developing software in an environment where technological obsolescence is a major concern.

> *US GAAP Source – 350-40 Intangibles – Goodwill and Other: Internal-Use Software*:
>
> When it is no longer probable that computer software being developed will be completed and placed in service, the asset shall

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be reported at the lower of the carrying amount or fair value, if any, less costs to sell. The rebuttable presumption is that such uncompleted software has a fair value of zero. Indications that the software may no longer be expected to be completed and placed in service include the following: a) A lack of expenditures budgeted or incurred for the project; b) Programming difficulties that cannot be resolved on a timely basis; c) Significant cost overruns; d) Information has been obtained indicating that the costs of internally developed software will significantly exceed the cost of comparable third-party software or software products, so that management intends to obtain the third-party software or software products instead of completing the internally developed software; e) Technologies are introduced in the marketplace, so that management intends to obtain the third-party software or software products instead of completing the internally developed software; f) Business segment or unit to which the software relates is unprofitable or has been or will be discontinued.

9.5 Drivers of IT Budget Levels

The IT asset composition of a firm's IT investment portfolio, as well as the level of IT budget/spending, should be determined by the firm's business and IT strategy. However as we have seen in Chapter 1 (p. **??**), the level of IT budget (how much the firm estimates that it will cost for IT to support the entire organization over the next 12 months) is likely to be influenced by a host of internal and external environmental factors [81]. In the following paragraphs, we are going to explore the potential role of these factors in more detail.

9.5.1 External Factors and IT Budget Levels

As we have seen in Chapter 2, the structure of the industry within which a firm operates determines the attractiveness of the industry, and by extension the profitability of firms in this industry. In general, and consistent with microeconomic theory, competition is less fierce and profitability higher as the number of competing firms decreases. Firms in oligopolistic markets tend to be more profitable than firms in perfectly competitive markets.

Firms are less likely to invest in IT if they know that this is not going to increase the firm's economic profits or improve its competitive position.

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Therefore, we conclude that IT spending is going to increase with such measures of industry attractiveness as market concentration.

The nature of the market within which the firm operates is another factor that may affect IT spending level. For example, the higher the level of market uncertainty, the higher the level of complexity. Uncertainty may manifest in terms of variation in such aspects as customer preferences, sales, and input prices. Coordination among business units, as well coordination with trading partners, becomes critical for success in such a market. Given the role of IT as a conduit that links activities within the firm's value chain, as well as across the expected supply chain, we expect that higher market uncertainty will be associated with higher level of IT spending.

Within specific industries, we expect to see variations in terms of the composition of their IT investment portfolios and levels of IT spending. As shown in Figure 9.1 [168], contrasting the IT portfolio management practices of top performing firms (ROA, profit margin, and revenue growth) revealed some difference across firms within the same industry. For example, top performers in the finance industry tend to spend 10% less than the rest of the industry, and their portfolio tends to have a higher concentration on infrastructure. Perhaps this reflects that IT is so critical for operations and mature in the finance industry, that all benefits come from efficiency and effectiveness [168]. IT spending levels of top performing firms are higher within the manufacturing (3%), wholesales/retail and transportation (7%), in information and services (11%), as well as across all industries (4%).

While the evidence regarding the Finance industry, shown in Figure 9.1, may be a bit dated, it points to an important fact, i.e., the overall role of IT in an industry. As we have seen in Chapter 3, the functional role of IT may be to automate, inform up and down the firm's organizational ladder, and transform. Depending on the primary role of IT across all firms, industries have been classified as automate, informate, or transform.

According to Kobelsky et al. [81], in very general terms, industries which are classified as automate, tend to be relatively stable. The technology that is used is mature, and the main competitive pressure is to lower cost structure. IT investment portfolios of firms operating in automate industry, tend to carry a higher percentage of initiatives which aim to build and incrementally enhance robust technologies. Compared to them, industries which are classifieds as transform, tend to be more dynamic. Firms in these industries tend to use technology to transform the competitive environment. These firms need to build an IT foundation that can support the firm's need for agility in implementing new IT solutions that will enable the firm to introduce a new product/service or enter a new niche market.

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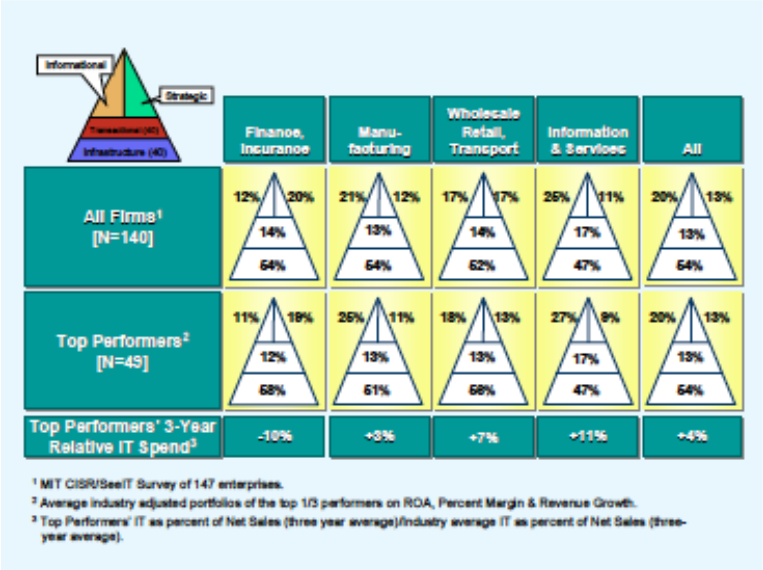

Figure 9.1: IT Portfolios of Top Performers (Weil and Aral 2005)

On the other hand, industries which are classified as informate, tend to operate in dynamic product markets but the technology that they use is relatively stable. In these firms, the focus is on flexible work and decision processes. Their IT investments tends to require large complementary investments in human capital (e.g., training) and structural capital (e.g., redesign of the work processes, decision structure and accountability, and reward structure) to move information more effectively. While these costs are substantial, they tend to be accounted for in operating unit budgets rather than IT budgets.

Overall, '*IT-related complexities and corresponding costs increase when firms must build, maintain, and adapt robust technology platforms to compete effectively in their industry. We therefore expect firms in industries where IT has an automate or transform strategic role to have higher IT budget levels than firms in industries where IT has an informate strategic role* Kobelsky et al. [81].

Finally, another external factor that is likely to affect the level of IT spending is that of technological innovations. As the SideNote: Lowe's IT Spending indicates, it has the potential to raise the level of IT spending substantially.

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SideNote: Lowe's IT Spending

Lowe's CEO Robert Niblock has characterized 2011 as "the largest single-year investment in IT in-store systems infrastructure in Lowe's history." That was the price of Lowe's going mobile. In May 2011, the company said it planned to hire 300 employees to augment its 1,000-plus IT staff. It revamped its wireless network infrastructure at more than 1,700 stores to accelerate Wi-Fi speeds by as much as eight times for customers and employees, ... it armed employees with 42,000 iPhones, augmented by custom apps and add-on hardware.[a]

[a] 18.

9.5.2 Internal Factors and IT Budget Levels

There are several internal factors, such as diversification, affordability, and growth opportunities that may affects a firm's level of IT spending. In the following paragraphs we will explore the logic behind each one of them.

Diversification: From a theoretical standpoint, firms justify diversification in terms of excess capacity in resources that cannot be transferred outside the firm due to high transaction costs. In reality, firms after reach a certain size and maturity are tempted to diversify. As the SideNote: Limits of Diversification indicates the downside risk is substantial.

The number and the nature of the markets that the firm chooses to enter are an important factor that affects IT spending. More specifically, this will depend on whether the firm chooses to enter into many related or unrelated markets. The former is known as related diversification and the latter as unrelated diversification. In general the expectation is that if a firm pursues related diversification, the firm tries to take advantage of production related synergies across different units. Therefore, there is a need to maintain tightly integrated information systems across all different units.

On the other hand, if the firm pursues unrelated diversification, different units can operate independently. Therefore, the need for direct communication, and by extension the need to integrate their information systems, is small. In conclusion, the argument has been that IT spending is going

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to be relatively higher for firms that engage in related than in unrelated diversification.

SideNote: Testing the limits of diversification

Companies of a certain size and maturity are often tempted to diversify. Sometimes they end up as a strange mix: one global oil enterprise acquired a computer firm, another a retailer. But most executives now realize that adding value to such a hodgepodge is hard. The upside gains of a diverse conglomerate are limited because all its businesses aren't likely to outperform at the same time, particularly since they tend to be relatively mature and therefore usually don't generate unexpected returns. But the downside isn't limited, because a mature business's performance can fall a lot further than it can rise. Poor aggregate results may affect the morale of a whole corporation and the way customers, suppliers, and potential employees perceive it.[a]

[a] 24.

Affordability: Many IT expenditures are regarded as discretionary, therefore when cash flow is tight, it is not uncommon for firms to delay, scale back, or cancel perceived non-critical IT investments. Therefore current spending is proportional to firms prior performance/cash flow. However, the level of cash flow which is available for new investments is likely to be limited by such factors as firm's debt and prior investments. More specifically, significant leverage and related debt service reduce the cash which is available for IT and other discretionary expenditures. Thus, the higher the firm's debt level the lower the IT budget level. Similarly, the current level of IT spending is determined by prior year's IT spending. IT initiatives that were implemented in prior years will require maintenance, thus limiting the free cash flow available for new projects.

Sales Growth: Firms with greater growth options are faced with multiple projects that have high net present value.Therefore, a firm's growth potential imposes a resource constraint for discretionary spending such as IT budgets.

9.6 Funding and Cost Allocation

As IT budgets become larger, another issue that becomes a point of discontent between IT and business managers is that of funding the IT spending (see SideNote: Rethinking IT Budgets - 2 on page 269). Some firms tend to

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allocate and prioritize major IT investments out of corporate budgets, while others may fund from the IT budget of a specific business unit, or on a case-by-case basis. In the following paragraphs, we will explore the three most common methods of funding IT spending: corporate budget, chargeback, and allocation.

Corporate budget means that the firm treats all IT related costs as an overhead that is covered directly from the firm's corporate budget. It is a relatively simple method. Funding IT through the corporate budget encourages the management to compare the operational and strategic benefits of new IT initiatives with the corresponding benefits of all other types of investments. This kind of comparison is likely to be considered more favorably by the firm's senior management when the IT projects are innovative or when the synergy between IT investments and other complementary investments is clear. In general, funding IT spending from the corporate budget tends to be favored by IT innovative firms.

With chargeback the cost of IT is charged back to departments or business units based on the actual usage. The IT department estimates the cost of providing certain services as well as usage data. Each department is charged based on how much they have consumed and they receive a monthly bill. The approach resembles the pay as you go concept in cloud computing. It is considered as one of the fairest methods, especially for handling operational/maintenance type of IT spending, and it motivates users to economize on IT resources.

Chargeback has two major drawbacks: First, it imposes a significant burden on the IT organization in terms of the data requirements. The IT organization must collect detailed information regarding cost of running the different systems, and record usage of each system by department or business unit. Second, it is likely to discourage business units from investing in new and innovative IT projects. McKeen and Smith [103] report that for a lot of firms strategic expenses are likely to be allocated on the budget of the business unit that will benefit from the investment.

SideNote: Rethinking IT Budgets - 2

... Corporate accountants and business unit leaders demand to know what departments are getting in exchange for their technology surcharges, which are often levied as a chargeback or a fee extracted from various operational divisions to fund the IT department.

... By their very nature, chargeback scenarios can instigate ill feelings between IT and other corporate departments. ... Chargeback

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> *mechanisms tend to cause underinvestment in critical infrastructure components, as well as significant internal dysfunctional behavior. Yet for many corporations, chargebacks are a fact of life ... In fact, chargebacks can be highly effective, especially in situations involving easily measured expenses. ... In some cases, chargeback arrangements are morphing into IT usage allocations. ... Allocation of IT resources based on usage often holds practical appeal for business unit leaders. ...By moving toward usage allocations, corporate IT departments might be able to use the budgeting process to begin functioning more as internal service providers to business unit customers. ...*[a]
>
> [a] 100.

With allocation, the IT cost is divided among departments or business units based on some metric that may or may not be directly related to actual usage. For example, cost may be allocated based on number of employees, users, desktops, or simply revenues generated by the department or business unit. Compared to chargeback, it is much simpler and departments know the amount that they will be charged so they can include it as part of their budget. The major drawback of this method is that of free riders. Organizations that use a lot of IT resources may be subsidized by departments that do not consume a lot of these resources.

Given the fact that there are pros and cons associated with both chargeback and allocation, many firms tend to introduce a hybrid approach. They use a formula that considers the number of users, size of the business unit, as well as historical spending/usage.

9.7 IT Portfolio Management

At any given time, a team of business and/or IT executives will vet projects proposals by matching them with the company's strategic objectives. IT portfolio management takes into consideration the fact that a firm should consider its IT projects as part of a portfolio of interrelated initiatives, rather than isolated IT projects.

The basic idea behind IT portfolio management is that IT initiatives are managed like a financial portfolio. This means that riskier strategic investments, such as high-risk, high-return stocks, will be balanced with safer investments, such as cash funds and government bonds.

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SideNote:

Every possible asset combination can be plotted in risk-return space, and the collection of all such possible portfolios defines a region in this space. The line along the upper edge of this region is known as the efficient frontier (sometimes the Markowitz frontier). Combinations along this line represent portfolios (explicitly excluding the risk-free alternative) for which there is lowest risk for a given level of return. Conversely, for a given amount of risk, the portfolio lying on the efficient frontier represents the combination offering the best possible return. Mathematically the Efficient Frontier is the intersection of the Set of Portfolios with Minimum Variance and the Set of Portfolios with Maximum Return.[a]

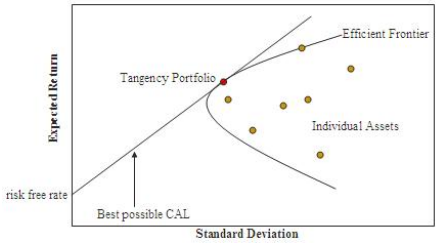

Figure 9.2: Efficient Frontier

[a]Wikipedia

Like financial investors, the firm's management needs to constantly monitor and evaluate these projects to make sure that they are on track. If some projects do not produce the desired results the management will have to decide whether they should allocate more resources or stop funding. The practice is based on the concept of efficient frontier in a financial portfolio (see SideNote: Efficient Frontier).

9.7.1 Steps in IT Portfolio Management

1. IT Portfolio Composition As in a financial portfolio you want to make sure that you know the current composition of your IT portfolio, as well as the proposed composition of the IT portfolio for the next year.[4]

The first challenge is how to establish the current composition of the IT portfolio. This means that you should try to report major IT initiatives that the firm has undertaken in the last three to four years. Weill and Aral [168] suggest that firms can classify IT initiatives in one of the following

[4]The discussion in section 9.7.1 is based on synthesis between Datz [26] and Weill and Aral [168].

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four types: transactional, informational, strategic, and infrastructure.[5] In a way these classifications reflect the functional roles of IT that we have seen in Chapter 3 (p. 81), and they mirror the four management objectives that motivate a firm's IT investments.

1. Transactional investments (transactional assets) are motivated by the desire to cut cost or increase output for the same cost. From a functional standpoint these are projects that aim to automate existing processes.

2. Informational investments (information assets) provide information to report, account, communicate, compliance, analyze, etc. From a functional standpoint these are IT initiatives that aim to either improve flow of information from top to bottom of the firm's organizational pyramid (informate down) or from bottom to the top (informate up).

3. Strategic investments (strategic assets) aim to provide the firm with a competitive advantage. From a functional standpoint these are IT initiatives that aim to transform the firm's competitive environment.

4. Infrastructure investments (infrastructure assets) form the foundation of shared IT services, which are used by many applications. Depending on their nature infrastructure investments aim to reduce cost through consolidation or increase flexibility/ability to implement future initiatives. The functional role of IT does not include a category that could match the infrastructure type of IT investments.

The second challenge would be to take inventory of all proposed changes in the firm's IT portfolio. This means that you need to record all new IT initiatives. As a starting point you may want to create a database that would capture the following pieces of information:

- project name
- project description
- champion (who has the power to make the decision, who will provide input, and who is going to be accountable).
- organizational or business unit requesting this IT initiative.
- estimated duration - implementation time

[5] Analysis the IT portfolio practices of large firms in the late nineties has revealed that on average firms allocate 54% of their IT investments to IT infrastructure, about 13% to transactional IT assets, 20% in informational IT assets, and 13% in strategic IT assets. Composition of IT portfolio varies across industries [168].

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- estimated cost
- expected functionality
- business objectives
- expected benefits

The information populating these fields should come from proposals prepared by heads of business units and IT managers.

2. Establish a process for evaluation of IT projects Same as in a financial portfolio you want to make sure that you have a process in place that indicates your risk-return preferences and match them with the portfolio that you will build. An IT steering committee should perform a multifaceted evaluation of these proposals. More specifically each proposal should be evaluated in terms of it alignment with strategic objectives (Chapter 3), expected financial contribution through NPV or IRR (Chapter 7), and risk assessment.

There are several forms of risk assessment of new IT initiatives. One of them (**risk profile**) is based on the combination of the firm's IT capability and magnitude of the expected payoffs associated with the IT initiative.

As shown in Figure 9.3, by considering low and high level of IT capability versus low and high levels of expected payoffs, we can classify a new IT investment in one of the following four categories:

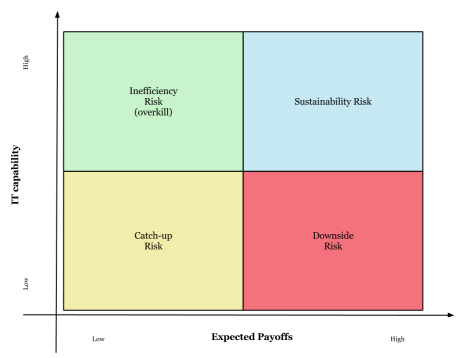

Figure 9.3: Risk profile

1. Sustainability risk. Will the specific IT investment provide the firm withe a sustainable competitive advantage?
2. Downside risk. If the firm fails in its implementation will this open the door to competitors to try to replicate successfully the same investment?
3. Catch-up risk. Will the firm be able to catch up to its competitors?
4. Inefficiency risk. Has the firm dedicated too many resources in an IT initiative that will not generate high returns?

Another form of risk assessment was introduced by McFarlan, McKenney, and Pyburn [101] and focuses in the following areas: 1) Identification of

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outcomes of unmitigated risk. These can be that the implementation may go over time, over budget, or deliver limited functionality; as well as risks associated with system failure (due to hacker attack or not). 2) Make the distinction between strategic versus operational risk: The former implies that the firm is in strategic or turnaround mode. Given that the focus in this mode is to support strategic initiatives, dealing with this risk requires a combination of IT and business expertise. On the other hand operational risk is likely to apply to firms in factory or strategic mode. Dealing with this kind of risk requires mostly IT expertise.

Evaluating the risk analysis of new projects requires concentration on several areas related to IT projects. 1) Technology related risk and experience. For example, newer technologies tend to be riskier. 2) Size of the project and resources needed. This will depend on the size of the company and the experience of a company. For example a $50 million project may be considered as a an average size and risk project for an IT capable Fortune 500 company but a huge investment and high risk for a medium size company. 3) Other areas that you may want to consider are the need for re-engineering, need for change management, and the number of people or departments involved or number of systems that will be linked.

Once this assessment has been completed, the IT steering committee will need to prioritize projects. A simple prioritization may include 4 to 7 IT strategic objectives such as limit technology risk, increase reliability of infrastructure, etc. This is followed by the selection of a metric per strategic objective. For example technology risk is low if the technology has already been used in a comparable organization. The process will be completed by weighing the criteria and developing a score.

Numerous variations of this process have been introduced by consultants and journalists (e.g., See SideNote: The Four Steps of September Tech Budgeting.).

3. Review actively manage your portfolio Like the financial investment portfolios, the IT steering committee will have to actively monitor and manage the firm's portfolio of IT initiatives.

9.7.2 Why ITPM?

What are some of the benefits of IT portfolio management?

- Avoid misaligned projects
- Approval process/prioritization

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- Accountability

What can you do with ITPM?

- Max value with min risk
- Improve communications with business leaders
- Encourage business unit leaders to think as a team and take responsibility for projects
- Allow planners to schedule resources more efficiently
- Reduce redundant projects and kill projects (*Why?*)

SideNote: The Four Steps of September Tech Budgeting

.. Here are four steps for CFOs to follow to be prepared. 1. Assemble a detailed list of all proposed projects. Make sure the list has a complete breakdown of all project costs, including future ones. Avoid situations in which tech people realize that some needed system requirements are missing after the project has been launched and then have to ask for more money from finance. 2. Categorize the projects. List them by size, function, and expected returns. Are they part of existing operations? What level of effort is needed to implement them? What are the resources required and what's the organizational impact? 3. Gauge the dependency of projects on each other. Can you, for instance, do project A if you don't do project B? 4. Prioritize the projects. These days, cost (or the lack of it) and cost efficiency tend to be top priorities. First determine which projects are "low-hanging fruit" — small efforts with few or no dependencies that can produce immediate results while consuming few or no resources. Next, group together "intermediate projects" - small to mid size ones that can spawn a measurable impact and have dependencies that can be fixed internally. Finally, list the large projects and new systems with potentially big dependencies that are being called for.[a]

[a] 75.

9.8 Business Value: Accounting/Finance Angle

Given the nature of this chapter there is no need to introduce an explicit accounting/finance angle.

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9.9 Summary and Concluding Remarks

The focus in this chapter has been on the IT budgeting process and IT budgets. More specifically, we focused on the responsibility of business and IT managers to establish priorities for where to spend money, set the rates to be charged for the use of IT, and decide on the allocation of budgets to business units.

As we have seen, the IT budgetary process is driven by the firm's business and IT strategy and strategic objectives. These along with the impact of a host of internal and external factors will specify the firm's IT spending level and functional IT budget. The conversion of the functional IT budget to the fiscal IT budget will be determined by the firm's fiscal strategy. Figure 9.4 outlines the main steps in a firm's IT budgeting process.

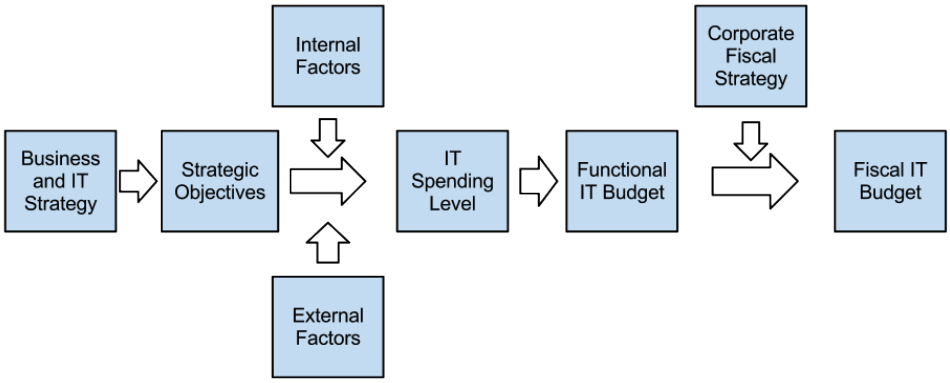

Figure 9.4: IT Budgeting Process

When done correctly IT budgets can be used to evaluate the performance of business units by comparing predicted and actual results. In Chapter 8, we will introduce a more comprehensive approach, i.e., IT balanced scorecard, for monitoring and evaluating the expected payoffs from major IT initiatives, such as ES adoption.

9.10 Practice Questions and Problems

9.10.1 Study Questions

1. On page 256 it was mentioned that technology executives would rather have a higher portion of their expenses capitalized because this makes

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their overall expenses smaller. Can you use a simple example to demonstrate this?

2. The categorization of IT projects into the three categories, running (keep the lights running), growing (support organic growth), and transforming the business (finding new ways of doing business using technology), should be cross-tabulated with value creation categories (revenue growth, reduce costs or grow market share). What does this mean? Explain.
3. Current accounting practices require that firms immediately expense most of IT expenditures [81, p. 980]. How is this practice going to affect the firm's net income in the period when IT expenses occur? How will this affect performance measures such as P/E ratio and market to Book value? What is the likely effect on the firm's debt covenants and cost of capital?
4. How does the following quote relate to the discussion on IT budgets? *It was only four or five years ago that the IT budgeting process could be summarized in three words: spend, spend, spend. Dave Raspallo, CIO of Textron Financial Corp., a $10 billion commercial-finance company, saw the danger signs of runaway projects early on, during the run-up to Y2K and the subsequent Internet boom. 'The perceived notion was that you had to spend your way out of trouble,' Raspallo says. With a $35 million IT operating budget and a $17 million capital budget, Raspallo can ill afford that kind of thinking or projects that don't add real value.* [95]
5. An approach to establish IT budget level is to use the industry average as a benchmark. Will this approach work for leaders or followers? Explain why.
6. 'Similar budget does not mean similar performance.' Do you agree with this statement?
7. How is the regulatory environment within which the firm operates, e.g., SOX, will affect the level of its IT budget?
8. 'A smaller number of competitors (high concentration) reduces the need for IT spending.' Do you agree with this statement? Explain why.
9. 'More uncertainty in the competitive environment leads to more spending.' Do you agree with this statement?
10. 'Diversification of products and services leads to more IT spending.' Do you agree with this statement? Explain why.
11. What areas of the IT budget do you expect that will be affected the most by a recession? Why?

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12. The title of an article by Everett [38] asked the following question: "Will a US recession demolish global IT budgets in 2008?" The same article was talking about the difference that an economic recession may have on an IT budget. According to the article "Capital expenditure budgets are set in advance and aren't generally affected too much by the weather. It's discretionary, ad-hoc project spend that tends to be trimmed first in the face of adverse conditions" Do you agree with this statement? Explain why.

9.10.2 Multiple Choice Questions

1. Which of the following statements regarding strategic and operational IT spending is correct?
   (a) operational cost can be classified as either operational or capital expenditures; strategic investments can be classified as either operational or capital expenditures.
   (b) operational cost are always classified as operational expenditures; strategic investments can be classified as either operational or capital expenditures.
   (c) operational cost can be classified as either operational or capital expenditures; strategic investments are always classified as capital expenditures.
   (d) operational cost always correspond to operational expenditures and strategic investments always correspond to capital expenditures.
2. IT spending is driven by strategic objectives but it is also mediated by several external and internal factors. Benchmarking or industry average is an example of external factor. We expect that the impact of this driver on a company's IT spending will be
   (a) higher for followers and lower for leaders.
   (b) high for both.
   (c) lower for followers and higher for leaders
   (d) low for both
3. Risk assessment requires a distinction between risk drivers and risk outcomes. Which one is a correct set of IT risk drivers?
   (a) Experience with technology, budget over-run, management resistance, desired functionality.
   (b) Management resistance, existing technology, prioritization, size, inventory of IT projects.

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(c) Complexity of project, experience with technology, need for re-engineering, size, resistance by management.
(d) Complexity of project, desired functionality, experience with technology, size, management involvement.

4. When we look at IT investment projects from a CFO's standpoint we make the distinction between value creation versus value extraction (sustain value).

   (a) Value creation is associated with investments in new projects and it is an defensive stance on investment; value extraction is associated with operationalization and it is an offensive stance.
   (b) Value creation is associated with investments in new projects and it is an defensive stance on investment; value extraction is associated with operationalization and it is a defensive stance.
   (c) Value creation is associated with investments in new projects and it is an offensive stance on investment; value extraction is associated with operationalization and it is an offensive stance.
   (d) Value creation is associated with investments in new projects and it is an offensive stance on investment; value extraction is associated with operationalization and it is a defensive stance.

5. Establishing a process for evaluation of IT projects is one of the steps in IT Portfolio management. This step will have the following sequence of actions:

   (a) preparation of project proposals and prioritization of projects.
   (b) preparation of project proposals, evaluation of project proposals, and prioritization of projects.
   (c) evaluation of project proposals and preparation of project proposals.
   (d) preparation of project proposals, prioritization of projects, and evaluation of project proposals.

6. Which one is NOT a benefit of IT portfolio management?

   (a) reducing the value of IT investments and risks.
   (b) improve allocation of resources.
   (c) detection and elimination of unsuccessful or overlapping projects.
   (d) improved alignment between IT projects and strategy.

7. The IT Portfolio is managed like a financial portfolio; riskier strategic investments (high-growth stocks) are balanced with more conservative investments (cash funds) and the mix is constantly monitored ...

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(a) to assess which projects are on track. You don't provide additional funding to projects which are over time or over budget.
(b) to assess which projects are on track. You don't provide additional funding to projects which are over time or over budget or not likely to achieve 100% of desired functionality.
(c) to assess which projects need more funding. You don't stop funding an existing project.
(d) to assess which projects are on track, which need help, and which should be shut down.

8. IT spending is driven by strategic objectives but it is also mediated by several external and internal factors. A company's decision to diversify in terms of products and services that it offers is an example of an internal factor. We expect that the impact of this driver on a company's IT spending will be as follows:

   (a) the higher the diversification the lower the spending.
   (b) the higher the diversification the higher the spending.
   (c) the lower the diversification the higher the spending.
   (d) none of the provided answers is correct.

9. Which of the following statements regarding level of IT budgets and state of economy is correct?.

   (a) In general the level of IT budgets tend to decrease during economic recessions because companies take advantage of their ability to negotiate better terms with their IT suppliers.
   (b) In general the level of IT budgets tend to increase during economic expansion because companies take advantage of their ability to negotiate better terms with their IT suppliers.
   (c) In general the level of IT budgets tend to increase during economic recessions because companies take advantage of their ability to negotiate better terms with their IT suppliers.
   (d) In general the level of IT budgets tend to decrease during economic expansion because companies take advantage of their ability to negotiate better terms with their IT suppliers.

10. IT spending is driven by strategic objectives but it is also mediated by several external and internal factors. A company's life cycle position (mature or growing) is an example of an internal factor. In general and relatively speakings, we expect that:

    (a) both mature and growing companies will spend more of their IT budget on operations.

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(b) growing companies will spend more of their IT budget on operations and mature will spend more in strategic projects.
(c) both mature and growing companies will spend more of their IT budget on strategic projects.
(d) growing companies will spend more of their IT budget in strategic projects and mature will spend more on operations

9.11 Business Analytics Practice Problems

9.11.1 Industry Level IT Budgets

The objective of this exercise is to analyze, compare, and try to explain industry level of IT spending for the following two industries: GIC=2510 and GIC=2520.

As we have seen in Chapter 1 (p. **??**) the industry classification provided by IW500 is not consistent with standard classification schemes. In this section, we will leverage a data set that was developed by Stratopoulos [151]. The study used an entropy analysis to convert the industry level IT spending from IW500 into four-digit GIC groups. In others words the new data set provides IT spending as a percentage of sales for each one of the four-digit GIC groups. The data set is available through the course website.

To complete this exercise you will have to perform the following tasks:

1. Generate descriptive statistics and graphs to compare IT spending as percentage of sales in these two industries.

2. Use median sales data for each industry to generate estimates of dollar values of IT spending in these industries. Generate appropriate descriptive statistics and graphs to compare patterns of IT spending in these two industries.

3. What elements of the industry structure analysis may help you explain differences in IT spending (percentage or dollar value) between these two industries?

4. Use Compustat data to generate the appropriate industry structure proxies from the previous step.

5. Generate descriptive statistics and graphs to compare industry structure and IT spending as between these two industries.

6. Which industry is likely to be more sensitive to economic conditions and why?

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7. Find economic data and see if they support your assumption in the previous step. Do economic conditions relate to IT spending (percentage or dollar value) in these two industries.

8. Tell the overall story of your analysis.

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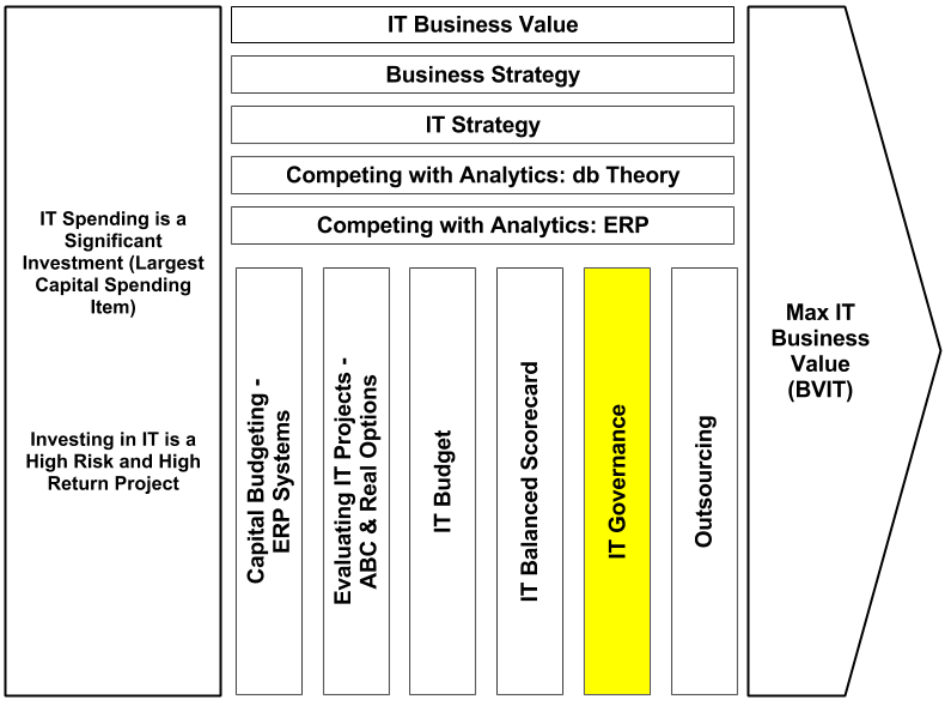
Chapter 10

Epilogue: IT Governance



Theophanis C. Stratopoulos, University of Waterloo

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Epilogue

The growing importance of IT in all organizations, cyberattacks, industrial espionage, and the passing of Sarbanes-Oxley, among others, have driven the growing need for IT governance in all organizations. Numerous magazines articles and reports by consulting firms have tried to sensitize TMTs and board members to the importance of IT governance as a prerequisite for achieving IT business value.

While the term IT governance (ITG) has become very popular it means different things to different people. For example Schwartz [136] in an article in the CIO Magazine, explains ITG as follows:

> *Simply put, it's putting structure around how organizations align IT strategy with business strategy, ensuring that companies stay on track to achieve their strategies and goals, and implementing good ways to measure IT's performance. It makes sure that all stakeholders' interests are taken into account and that processes provide measurable results. An IT governance framework should answer some key questions, such as how the IT department is functioning overall, what key metrics management needs and what return IT is giving back to the business from the investment it's making.*

According to Gartner [47], ...

> *IT governance (ITG) is defined as the processes that ensure the effective and efficient use of IT in enabling an organization to achieve its goals.*

Last but not least, the IT Governance Institute [67] defines it as follows:

> *IT governance is the organizational capacity exercised by the board, executive management and IT management to control the formulation and implementation of IT strategy and in this way ensure the fusion of business and IT.*

In parallel, there has been a movement to sensitize board members and top management teams (TMT) to the importance of being more actively involved with IT. A recent article in the magazine Corporate Board Member [54] made an explicit call to board members.

> *Congratulations! Your company has just spent a heap on a dazzling new information-technology system. It didn't come*

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> *cheap, but management - the CEO, CFO, and CIO (chief information officer) - convinced the board that the investment will boost productivity, eliminate bottlenecks, sharpen your competitive edge, and enable you to respond much more quickly to market conditions. Maybe it will even help you emerge triumphant from the current economic turmoil.*
>
> *U.S. companies invest nearly 500 billion a year in their IT ... Yet many directors still wonder if they're getting value for their money.*
>
> *[Companies] whose boards made sure they had strong IT governance and exercised it generated profits 20% higher than those with similar business strategies but weak IT oversight.*

A consensus emerging from this and other similar articles is that board members should be able to measure the payoffs from IT investments. Board members need to understand that a dialog with IT executives is not about technology, and it should not be about technology. The dialog should be about overseeing an organization, i.e., the IT organization, that delivers services to the rest of the company. As with any other key function, this boils down to questions of cost, risk, and benefit. If the IT unit doesn't have the answers, the directors' next step is to make sure it gets them. The authors urge board members to think holistically, know the real cost, and understand the risk and size up the competition.

How a board goes about governing IT activities generally depends on a company's size, industry, and competitive landscape. In other words, a board's approach to ITG has to be context specific. The board will have to consider the company's history (reflected in resources and capabilities that the company owns), external environment (industry structure), current competitive and financial position, and quality of IT and non-IT management. Nolan and McFarlan [116] recommend the use of McFarlan's strategic grid.

For several practitioners and researchers the term ITG is associated with the firm's TMT. Approaching ITG from the senior management's standpoint Weill [167] defines ITG as a *framework of decision rights and accountabilities to encourage desirable behavior in the use of IT*. This definition prompts the need to make the distinction between IT governance versus IT management.

On any given day managers involved with IT related issues, may have to make decision related to such issues as which software application is most suitable for our needs, which vendor to choose, what implementation method to use, should we host it locally or on the cloud, how to finance it, and who should be trained on its use? Conceptually, ITG is an antecedent of such

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IT management decisions because it specifies the spectrum of basic choices that need to be made, and who is going to be responsible for making these kind of decisions.

In some firms there is an explicit process in place, i.e., IT governance, that specifies who has such decision rights, for what decisions, as well as who is accountable in case of deviations of actual from expected results. However, in firms that do not have an explicit process in place, decision rights and accountability are assigned on an *ad hoc* basis. Without a formal ITG, the wrong manager may be forced to make decisions on issue that he or she is not suitable to decide, and without knowing the financial, managerial, and technical ramifications of these decision for the rest of the company. It is quite possible that someone with a global view of the firm might have made a different choice.

Therefore, the issue is not whether firms have ITG or not, because at an elementary level all firms have some form of ITG, the issue is whether their ITG is effective. Analyzing the practices of firms with effective IT governance practices in terms of their approach to maximize the payoffs from IT Investments, researchers have identified the following patterns:

1. Clear business strategy and a vision for IT: Firms with effective ITG tend to have a well defined business strategy and a clear understanding of the role that IT plays in helping the firm achieve its strategic objectives. *This relates to material in Chapters 1, 2 and 3.*
2. Document cost and benefits: They document resources that the firm allocates towards IT initiatives, as well as the value that the firm extracts from its IT investments. *This relates to material in Chapters 7-9.*
3. Implement alignment of IT with business strategy: They tend to design and develop organizational practices to ensure that IT will fit to their business strategy. *This relates to material in Chapters 3 and 4. Chapter 6 provides explicit reference to cost/risk and expected benefits associated with enterprise systems.*
4. Accountability for organizational changes: They understand that extracting the maximum possible value from IT initiatives may require organizational changes and they assign accountability for achieving these organizational changes. *This relates to material in Chapter 8.*
5. Knowledge management: They understand the importance of documenting the importance of capturing knowledge that the organization has accumulated from prior IT initiatives and share this across the organization. *A knowledge management system is database system (see*

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Chapter 5), however its successful implementation will depend on the firm's organizational IT capability (see Chapter 3).

Several studies have shown that IT governance matters. The benefits of effective IT governance have been linked to how well it enables IT to help the firm achieve the following four objectives: cost effective use of IT, effective use of IT for growth. effective use of IT for assets utilization, and effective use of IT for business flexibility. Figure 10.1 [169], provides an example of how to assess how well a firm's ITG contributes to achieving its goals. Firms with well thought and effective forms of IT governance tend to be 20% of more profitable than their competitors that have implemented a similar strategy, and achieve 40 to 60% higher returns from comparable IT investments.

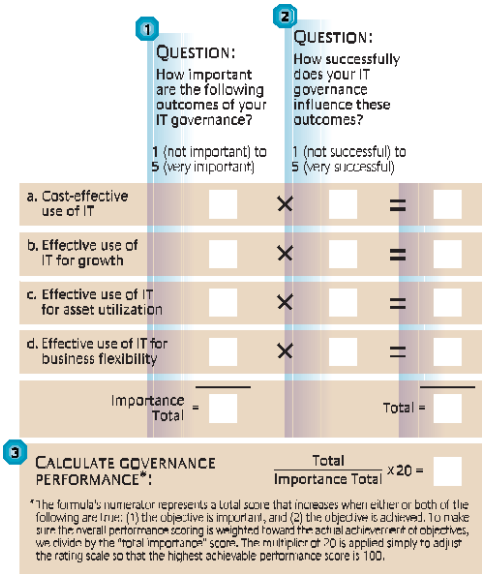

Figure 10.1: Accessing ITG Performance

The ITGI [67] and an article produced by McKinsey consulting [9] bridge the two previous views in the sense that they define ITG as the responsibility of the board of directors and executive management.

The McKinsey article [9] takes the following position:

> *Businesses are becoming increasingly digital and it's not just a matter of process automation or resource-planning systems. Technology trends such as big data, cloud computing, mobility, and social media are giving rise to new marketing and operational capabilities. Indeed, technology has become too embedded in the fabric of the business- and too critical for competitive performance-to be left to the IT function alone.*
>
> *As a result, many senior-executive teams have been called upon to get involved in technology issues. Boards are also beginning to take a strategic view of how technology trends are shaping*

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their companies' future. More boards than ever before are asking questions that ensure executives focus on the right issues. ..

The value at stake from getting technology right is typically quite large. Recent research indicates that about half of MA synergies depend on IT, which makes it a core driver of deal success. The risk of cyberattack is another area that can directly affect both operations and the broader brand or business reputation. In fact, some boards are beginning to direct their risk committees to oversee cybersecurity issues.

There are also many other competitive opportunities and threats that are driven by technology trends, such as new entrants causing industry disruptions with radically different cost structures or game-changing innovations. What's more, major corporate investments or transformations, such as supply-chain or operating-model transformations, often have a major IT component that can imperil delivery if anything goes wrong.

The IT Governance Institute (ITGI)[1] defines ITG as follows: "IT governance is the responsibility of the board of directors and executive management. It is an integral part of enterprise governance and consists of the leadership and organisational structures and processes that ensure that the organization's IT sustains and extends the organization's strategies and objectives" [67, p. 10].

According to the IT Governance Institute [67], ITG is concerned with two things: IT's ability to deliver value to the business and mitigation of IT risks. The first is driven by strategic alignment of IT with the business. The second is driven by embedding accountability into the enterprise. Both need to be supported by adequate resources and measured to ensure that the results are obtained [67, p. 19]. According to ITGI (see Figure 10.2), the main aim of ITG is to ensure effective utilization of IT by focusing on the following areas:

1. Strategic Alignment

[1]The IT Governance Institute (ITGI) was established in 1998 in recognition of the increasing criticality of information technology to enterprise success. In many organizations, success depends on the ability of IT to enable achievement of business goals. In such an environment, governance over IT is as critical a board and management discipline as corporate governance or enterprise governance. Effective IT governance helps ensure that IT supports business goals, maximizes business investment in IT, and appropriately manages IT-related risks and opportunities. Source: http://www.itgi.org/template_ITGI923a.html?Section=About_ITGI&Template=/ContentManagement/HTMLDisplay.cfm&ContentID=57434

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2. Risk Management
3. Resource Management
4. Value Delivery, and
5. Performance Measurement.

10.1 Concluding Remarks

Though not explicitly stated, the underlying theme of these teaching notes has been that of IT governance. We started by looking at IT business as a way of sensitizing you to magnitude and potential of IT initiatives. Right from the beginning, we made it clear that it is naive to expect that simply spending more on IT should manifest in better financial and/or market performance. IT initiatives are risky and only firms that invest in new technologies carefully would see the expected results. Our position has been that not all firms have to be IT innovative, however all firms need to align their IT initiatives with their corporate priorities, they need to monitor the risks of IT initiatives to ensure the expectations would materialize in term of payoffs.

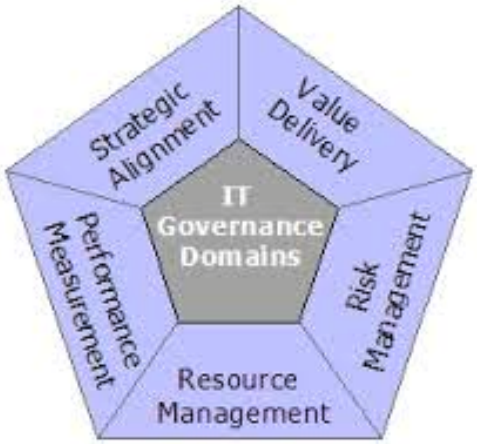

Figure 10.2: ITG Focus Areas

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Part IV

Appendix

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Appendix A

How to Extract Financial Data from Compustat

Intended Learning Outcomes

The objective of this Appendix is introduce students to Wharton Research Data Services (WRDS), one of the most comprehensive repositories of accounting/financial data. More specifically, we are going to focus in Compustat Capital IQ (henceforward Compustat), which is one of the libraries/-databases in WRDS that houses financial statement data of all companies that are publicly traded.

By the end of the chapter students should have achieved the following objectives:

1. Understand the data structure of the Compustat database.
2. Know what financial data are available per firm and time periods covered.
3. Be able to extract financial statement data for a single firm or an entire industry.

A.1 Compustat

Financial statement analysis requires a point of reference. This point can be the company itself or other firms/competitors. When the point of reference is the company itself, we compare the firm's performance in current period to its performance in prior periods (this means we use time-series data). In section (A.1.1), we will learn how to extract data from Compustat for a

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single company.

When the point of reference is a list of competitors or the entire industry, we compare the firm versus its competitors at a given point in time (this means we use cross-sectional data) or compare the firm versus its competitors over time (this means we use panel data). In section A.1.2, we will learn how to extract data for an entire industry.

A.1.1 Compustat: Single Firm

We will start by learning how to extract financial data needed to generate profitability measures for Apple, from 2010 up to 2016. This means that we need the following variables:

1. income before extraordinary items (Compustat code=IB)
2. sales (Compustat code=SALE)
3. operating income before depreciation (Compustat code=OIBDP)
4. cost of goods sold (Compustat code = COGS)
5. total assets (Compustat code = AT)

To access Compustat, go to `https://wrds-web.wharton.upenn.edu/wrds/` and enter your user name and password.[1] From the menu (subscriptions) select Compustat Capital IQ > North America - Daily > Fundamentals Annual, and in the new window make the following selections:

1. **Choose data range**
   (a) Date Variable: select **Fiscal Year**
   (b) Confine the date range to January 1, 2010 to December 31, 2016.
2. **Apply company codes**
   (a) We need to specify the format of the company codes that we will use to extract data from Compustat. The most common selections are Ticker, GVKEY (a unique number assigned to each company by Compustat), SIC (Standard Industry Classification), and NAICS (North American Industry Classification System).
   (b) If we don't know the company's code, we can use the **[Code Lookup]** feature in Compustat. For example, using the code lookup, we can find that the ticker symbol for Apple is AAPL and enter it manually, as shown in Figure A.1.[2]

[1] Your class instructor will provide you with the user name and password. Please, do

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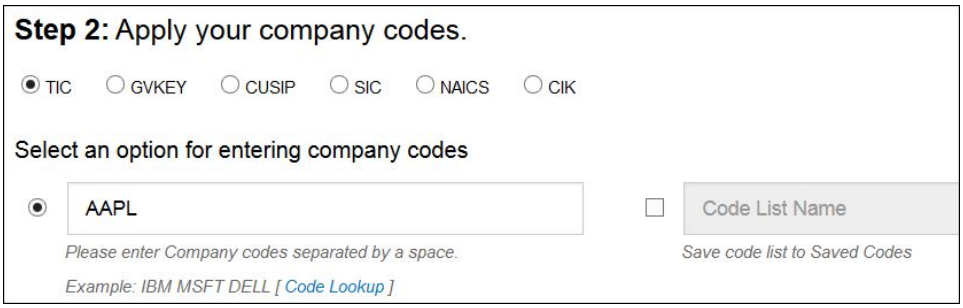

Figure A.1: Compustat: Entering Company Code(TIC)

(c) In the **Screening Variables** section de-select all output options. Given the nature of our analysis, we would not be using this output.

(d) In the **Conditional Statements** section, we do not need to specify any conditions in order to extract sales data for Apple (AAPL). We will use these conditions in our next stage, when we extract data for an entire industry.

3. **Choose variable types**

   (a) Under "**Select Variable Types**" select "Data Items".

   (b) When it comes to the financial variables that we want to extract we have the following options:

      i. We can browse by category. For example, if we select the category "Identifying Information ...", we will see a list of available variables. As we can see from Figure A.2, we used this approach to select Company Name and Ticker Symbol.

      ii. The second option would be to search for specific variables. For example, we know that we want to extract Income Before Extraordinary Items. If we start typing "Income befor..." the list of options will show up, and we can select the right variable (See Figure A.3). Searching for sales (SALE), operating income before depreciation (OIBDP), cost of good sold (COGS), and total assets (AT) we select the remaining

NOT try to change the password! This is a class password, not an individual password.

[2]If we want to extract data for multiple companies, we can create a spreadsheet with company codes and upload it. The spreadsheet must have the companies sorted by GVKEY, CIK (numerical order) or Ticker symbol (alphabetical order). The spreadsheet must be saved as a text file (i.e., with extension ".txt".)

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Figure A.2: Compustat: Variable Selection from List

variables. In addition to the variables needed for the calculation of ROA, we also select variables that show the firm's industry classification (NAICS and SIC), as well as the firm's headquarter location (LOC).

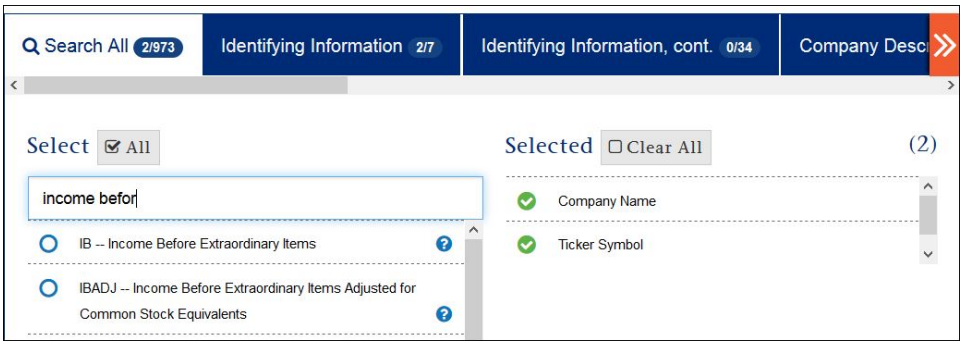

Figure A.3: Compustat: Search for Variable Selection

iii. Please notice that financial variables are organized by the underlying financial statement. We can browse financial variables available in balance sheet, income statement, and cash flow statements. Various items, such common shares, auditor's opinion, and dividends per share are listed under Miscellaneous items or Supplemental Data items. You may want to spend some time familiarizing yourself with the list of variables.

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4. **Select query Output** In this final section, we make selections regarding the format of the output file, compression, and date format.

   (a) The output format will depend on the nature of the analysis we are planning to do, and the software package that we will use to do the statistical analysis. For data analysis with R, "comma delimited text (*.csv) is the best option. However, since this is just an exercise for learning how to extract data, we will choose HTML so we can see the output.
   (b) For relatively small files, like the one in this exercise, there is no need to compress the output.
   (c) Leave the default selection for the date format.
   (d) Since we will be using a common account for the entire class, do not provide your email and do not save the query.

5. **Select query Output** - Review your choices to make sure they are correct and click the "submit query" button.
   A new window will open showing the query summary (Figure A.4). It is very important to make sure that the output shown matches the choices that we have made.

As you can see in Figure A.4, the output shows the date range that we have selected (Jan 2010 to Dec 2016), the input code (AAPL), the fact that there are no constraints, and the seven variables that we have chosen: company name=CONM, ticker symbol=TIC, total assets (AT), cost of good sold (COGS), income before extraordinary items (IB), operating income before depreciation (OIBDP), and sales (SALE). Notice that industry classifications (NAICS and SIC) and headquarter location (LOC) do not show as variables selected.

Once the query has been generated, we click on the link and we can see the results on the browser. The output (a partial screen shot shown in Figure A.5) shows the financial data for Apple, starting with fiscal year 2000, as well as the industry classification (NAICS = 334220[3] and SIC = 3663). In the following section, we will use this information (industry classification) to extract data for the entire industry.

[3]From the web site of Statistics Canada (http://www23.statcan.gc.ca/imdb/p3VD.pl?Function=getVD&TVD=307532) we can find that NAICS=334220 is for firms in *Radio and television broadcasting and wireless communications equipment manufacturing.*

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Data Request Summary

Your output is complete. Click on the link below to open the output file.

4a1afb7347053eda.htm (8 KB, 7 observations 12 variables)

Download instructions

Internet Explorer and Firefox users... Right-click and select "Save Target As..."

Citation instructions

To cite this data use the following format:

Wharton Research Data Services. "WRDS" wrds.wharton.upenn.edu, accessed 03/20/2018.

Data Request ID	4a1afb7347053eda
Libraries/Data Sets	compd/funda /
Frequency/Date Range	ann / 01Jan2010 - 31Dec2016
Search Variable	TIC
Input Codes 1 item(s)	AAPL
Conditional Statements	n/a
Output format/Compression	htm /
Variables Selected	CONM TIC AT COGS IB OIBDP SALE
Extra Variables and Parameters Selected	C INDL FS STD

Figure A.4: WRDS Data Request Summary

Compustat Fundamentals Annual

Global Company Key	Data Date	Data Year - Fiscal	Ticker Symbol	Current ISO Country Code - Headquarters	North American Industry Classification Code	Standard Industry Classification Code	Company Name	Assets - Total	Cost of Goods Sold	Income Before Extraordinary Items	Operating Income Before Depreciation	Sales Turnover (Net)
001690	20100930	2010	AAPL	USA	334220	3663	APPLE INC	75183.0000	38609.0000	14013.0000	19317.0000	65225.0000
001690	20110930	2011	AAPL	USA	334220	3663	APPLE INC	116371.0000	62609.0000	25922.0000	35612.0000	108249.0000
001690	20120930	2012	AAPL	USA	334220	3663	APPLE INC	176064.0000	84641.0000	41733.0000	58446.0000	156508.0000

Figure A.5: Compustat Fundamentals Annual for Apple

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A.1.2 Compustat: Entire Industry

Being able to assess how a company does versus its competitors is very useful for all accounting (e.g., auditing, management accounting, and financial statement analysis) and finance (e.g., financial management, investment analysis) areas. Finding competitors that are 100% comparable to the firm that we want to assess is almost impossible. One option is to hand-select a handful of direct competitors. The second option is to use one of the commonly accepted industry classification systems (e.g., NAICS, SIC), which try to classify firms in groups based on their operations.[4]

As we have seen in Figure A.5, Apple's NAICS classification is 334220. In the following paragraphs, we will learn how to extract fundamental annual data for an entire industry (please keep in mind that Compustat contains only the publicly traded competitors of Apple). For this we will simply modify our existing Compustat query as follows:

1. **Date range**: select Fiscal Year and confine the date range to January 1, 2010 to December 31, 2016.
2. **Apply your company codes** Instead of searching by a single firm, select '*Search the entire database*'
3. **Screening Variables** - de-select all output options. Given the nature of our analysis, we would not be using this output.
4. We leave the same variables selected as we had them in the Apple query. Our list of variables includes the following:

   (a) company name=CONM,
   (b) ticker symbol=TIC,
   (c) headquarter location (LOC),
   (d) industry classifications (NAICS and SIC)
   (e) total assets (AT),
   (f) cost of good sold (COGS),
   (g) income before extraordinary items (IB),
   (h) operating income before depreciation (OIBDP), and
   (i) sales (SALE)

5. Under **Conditional Statements** we select NAICS from the first drop down menu and set it equal to **334220** (See Figure A.6).

[4]Please visit the Wikipedia to learn about NAICS and SIC, as well as other commonly used industry classification systems https://en.wikipedia.org/wiki/Industry_classification.

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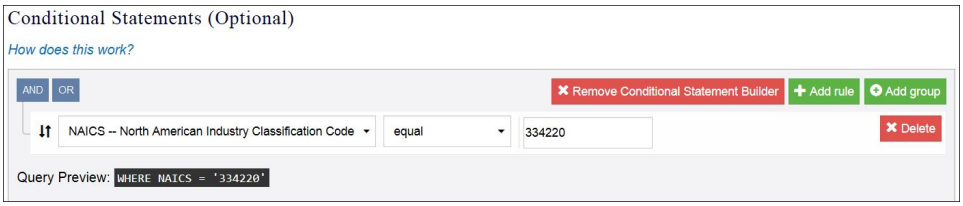

Figure A.6: Compustat: Conditional Statement

6. **Select query Output** We select "comma delimited text (*.csv) as output format. The file is relatively small and there is no need to compress it. Leave the default selection for the date format.
7. Since we will be using a common account for the entire class, do not provide your email and do not save the query.
8. Submit Query

As mentioned above, it is very important to verify that the summary of our query matches the choices that we have made. As we can see in Figure A.7, the output shows the date range that we have selected (2010-2016), the fact that we are extracting data from the entire database `(-all-)`, there is a constraint (`NAICS eq 334220`), and all the variables we have chosen.

Finally, we follow on screen directions to save the csv file to a local directory and give it a more useful name (e.g., `industryAAPL_2010_2016.csv`).

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Your data query results will be accessible for the next 48 hours in the MyWRDS section of the website.

Notice:
Your use of WRDS and this data extract must comply with the WRDS Terms of Use. There may be additional usage restrictions that are governed by your institution's licensing of specific databases. If you have any questions about data licensing and appropriate usage, please contact WRDS using the Support form.

Data Request Summary

Your output is complete. Click on the link below to open the output file.

6d3b0ef3d5d1e949.csv (44 KB, 441 observations 13 variables)

Download instructions

Internet Explorer and Firefox users... Right-click and select "Save Target As..."

Citation instructions

To cite this data use the following format:

Wharton Research Data Services. "Complete Financial Statements (XLS)" wrds.wharton.upenn.edu, accessed 01/07/2018.

Data Request ID	6d3b0ef3d5d1e949
Libraries/Data Sets	compm/funda /
Frequency/Date Range	ann / 01Jan2010 - 31Dec2016
Search Variable	TIC
Input Codes all item(s)	-all-
Conditional Statements	NAICS = \'334220\'
Output format/Compression	csv /
Variables Selected	CONM TIC AT COGS IB OIBDP SALE
Extra Variables and Parameters Selected	C INDL FS STD

Figure A.7: Compustat: Data Request Summary - Industry

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Appendix B

Financial Ratios with Compustat Data

B.1 Performance Measures

The following paragraphs provide a summary of some of the most commonly used financial performance measures and how to calculate them based on Compustat data.

B.1.1 Profitability measures

Depending on how we measure profits, we can have several variations. All of them capture profit generated per dollar of sales. Some of the most common ones are listed below:

Profit margin (PM_{it}) defined as income before extraordinary items (Compustat code=IB) to sales (Compustat code=SALE).[1]

$$PM_{it} = \frac{IB_{it}}{SALE_{it}} \tag{B.1}$$

Operating margin (OM) defined as operating income before depreciation (Compustat code=OIBDP) to Sales (SALE).

$$OM_{it} = \frac{OIBDP_{it}}{SALE_{it}} \tag{B.2}$$

Gross margin (GM) defined as sales (SALE) minus cost of goods sold (Compustat code = COGS) over sales (SALE)

[1] In the following formulas, the subscript i refers to the specific firm and the subscript t refers to the time period.

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$$GM_{it} = \frac{SALE_{it} - COGS_{it}}{SALE_{it}} \tag{B.3}$$

Return on assets (ROA) measures a firm's ability to generate profits per dollar of assets. The formula is the same as above, the only difference is that the denominator is based on average assets ($AVAT_{it} = \frac{AT_{it}+AT_{it-1}}{2}$).

The first, version of ROA is based on income before extraordinary items (IB), i.e., the same numerator as the profit margin (PM):

$$ROA\ (with\ PM)_{it} = \frac{IB_{it}}{AVAT_{it}} \tag{B.4}$$

The second specification of ROA is based on operating income before depreciation (OIBDP), i.e., the same numerator as the operating margin (OM):

$$ROA\ (with\ OM)_{it} = \frac{OIBDP_{it}}{AVAT_{it}} \tag{B.5}$$

The third version of ROA based on gross profits, i.e., the same numerator as the gross margin (GM):

$$ROA\ (with\ GM)_{it} = \frac{SALE_{it} - COGS_{it}}{AVAT_{it}} \tag{B.6}$$

B.1.2 Common Efficiency Measures

These measures capture the firm's ability to leverage its assets or expenditure to support sales. Alternatively, they can be seen as conversion rates, i.e., ability to convert assets or expenditures to sales.

The first one, total asset turnover (TATO), measures volume of sales generated per dollar of total assets (TA). Recall that average total assets has been defined as $AVAT_{it} = \frac{AT_{it}+AT_{it-1}}{2}$.

$$TATO_{it} = \frac{SALE_{it}}{Average\ TA_{it}} \tag{B.7}$$

The second one, property plant and equipment turnover (PPETO), measures volume of sales generated per dollar of property plant and equipment (Compustat code = PPENT). Average property plant and equipment is defined as follows: $Average\ PPE_{it} = \frac{PPENT_{it}+PPENT_{it-1}}{2}$.

$$PPETO_{it} = \frac{SALE_{it}}{Average\ PPE_{it}} \tag{B.8}$$

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With the third one, intangibles turnover (INTTO), we focus on the firm's ability to generate sales based on its intangible assets (Compustat code = INTAN). As the role of information technology in firms is increasing, more and more of their value is based on intangible assets (re-visit the story by Monga [107] on p. **??**). Average intangible is calculated as follows: $Average\ INTAN_{it} = \frac{INTAN_{it}+INTAN_{it-1}}{2}$.

$$INTTO_{it} = \frac{SALE_{it}}{Average\ INTAN_{it}} \tag{B.9}$$

Employee turnover or sales per employee (EMPTO) measures the volume of sales generated per employee. For the calculation, we use number of employees reported (Compustat code = EMP). The average number of employees is calculated as follows: $Average\ EMP_{it} = \frac{EMP_{it}+EMP_{it-1}}{2}$.

$$EMPTO_{it} = \frac{SALE_{it}}{Average\ EMP_{it}} \tag{B.10}$$

The last one, advertising turnover (ADVTO), is defined as sales (SALE) to advertising expenses (Compustat code = XAD).

$$ADVTO_{it} = \frac{SALE_{it}}{XAD_{it}} \tag{B.11}$$

B.1.3 Cost Measures

These measures are used to evaluate the efficiency of the company's cost structure. The first one looks at the firms cost of goods sold (Compustat code = COGS) as a percentage of sales (COGS2S).

$$COGS2S_{it} = \frac{COGS_{it}}{SALE_{it}} \tag{B.12}$$

The second one evaluates how well a company can control its overhead expenses, i.e., its selling general and administrative expenses (Compustat code = XSGA) as a percentage of sales (SGA2S).

$$SGA2S_{it} = \frac{XSGA_{it}}{SALE_{it}} \tag{B.13}$$

B.1.4 Cash conversion ratios

The last set of ratios reflect the firm's ability to manage its receivables, payables, and inventory. The first one, days' receivables (ARDAYS), is defined as accounts receivable (Compustat code = RECT) over sales adjusted for days in a year.

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$$ARDAYS_{it} = \left(\frac{RECT_{it}}{SALE_{it}}\right) \times 365 \tag{B.14}$$

The second one, days' payables (APDAYS), is defined as accounts payable (Compustat code = AP) over cost of goods sold (COGS) adjusted for days in a year.

$$APDAYS_{it} = \left(\frac{AP_{it}}{COGS_{it}}\right) \times 365 \tag{B.15}$$

The third one, days' inventory (INVDAYS), is defined as Inventory (Compustat code = INVT) over cost of goods sold (COGS) adjusted for days in a year.

$$INVDAYS_{it} = \left(\frac{INVT_{it}}{COGS_{it}}\right) \times 365 \tag{B.16}$$

Total cash conversion cycle (TCCC) is defined as days' receivable minus days' payable + days' inventory.

$$TCCC_{it} = ARDAYS_{it} - APDAYS_{it} + INVDAYS_{it} \tag{B.17}$$

The last one, provisions for doubtful accounts (PDAR), is defined as estimated doubtful accounts receivable (Compustat code = RECD) over accounts receivable (AR).

$$PDAR_{it} = \frac{RECD_{it}}{AR_{it}} \tag{B.18}$$

B.1.5 Tobin's q

The Estimation of Tobin's q can be quite elaborate. However, there are two approximation which are used. The first one, uses the market to book value equity (MB), which is specified as follows:

$$MB = \frac{PRCC_C \times CSHO}{CEQ} \tag{B.19}$$

Where,

- PRCC_C is the Compustat code for Price Close - Annual - Calendar
- CSHO is the Compustat code for Common Shares Outstanding
- CEQ is the Compustat code for Common/Ordinary Equity - Total

The second approach, by Chung and Pruitt [17], provides a relatively more accurate approximation. Tobin's q is calculated as the ratio of the

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market value of the outstanding financial claims on the firm over the current replacement cost of its assets. Typically, this is defined as in equation B.20.

$$\textit{Tobin's } q = \frac{MVE{+}PS{+}DEBT}{Total\ Assets} \tag{B.20}$$

where

- MVE is the product of a firm's share price and the number of common stock shares outstanding,
- PS is the liquidating value of the firm's outstanding preferred stock,
- $DEBT$ is the value of the firm's short-term liabilities net of its short-term assets, plus the book value of the firm's long term debt ($DEBT = CurrentAssets - CurrentLiabilities + LongTermDebt$), and
- $TotalAssets$ are the book value of the total assets of the firm.

Chung and Pruitt [17] suggest that equation B.21 provides a very good approximation of the original Tobin's q.

$$\textit{Compustat based Tobin's } q = \frac{CEQ{+}PSTK{+}ACT\text{-}LCT{+}DLTT}{AT} \tag{B.21}$$

where

- Common/Ordinary Equity - Total (Compustat code = CEQ)
- Preferred/Preference Stock (Capital) - Total (Compustat code = PSTK)
- Current Liabilities - Total (Compustat code = LCT)
- Current Assets - Total (Compustat code = ACT)
- Long-Term Debt - Total (Compustat code = DLTT)
- Assets - Total (Compustat code = AT)

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Appendix C

Accounting Proxies for Industry Structure

C.1 Proxies for Barriers to Entry

Property plant and equipment (PPE), research and development (R&D) expenditures, as well as capital expenditures have been suggested as indicators of barriers to entry to an industry. The logic behind these measures is that a firm that needs to enter and compete successfully with the average firm in the industry, would need to invest in the same property plant and equipment, and allocate the same level of expenditures in R&D and capital as the average firm. The higher the investment/expenditure needed to enter the market, the higher the barrier to entry.

- **Industry average PPE (INDPPE)** is defined as the weighted average of property, plant, and equipment of all firms in an industry. A firm's market share, calculated as the ratio of its sales to industry aggregate sales ($SALE_{it}/\sum_{i=1}^{n} SALE_{it}$), is used as weight.
  In order to calculate INDPPE based on Compustat data, we need to identify the industry that we want to analyze, and extract property plant and equipment (Compustat code = PPENT), as well as sales (Compustat code = SALE) data, for all n firms in the industry during the period t.

$$INDPPE_t = \sum_{i=1}^{n} \frac{SALE_{it}}{\sum_{i=1}^{n} SALE_{it}} PPENT_{it} \tag{C.1}$$

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- **Industry average R&D (INDXRD)** is defined as the weighted average of R&D expenditures of all firms in an industry. To calculate INDXRD based on Compustat data, we need to identify the industry that we want to analyze, and extract R&D expenditures (Compustat code = XRD) as well as sales (Compustat code = SALE) data, for all firms in the industry.

$$INDXRD_t = \sum_{i=1}^{n} \frac{SALE_{it}}{\sum_{i=1}^{n} SALE_{it}} XRD_{it} \tag{C.2}$$

- **Industry average capital expenditures (INDCPX)** is defined as the weighted average of capital expenditures of all firms in an industry. To calculate INDCPX, we extract capital expenditures (Compustat code = CAPX), as well as sales (Compustat code = SALE) data, for all firms in the industry.

$$INDCAPX_t = \sum_{i=1}^{n} \frac{SALE_{it}}{\sum_{i=1}^{n} SALE_{it}} CAPX_{it} \tag{C.3}$$

- **Log of Market Size (MKTS)** or Market size, measured as the sum of the log sales of all firms in an industry is another proxy for barriers to entry. Its calculation requires the natural log of firm sales (Compustat code = SALE). Please, note that we cannot take the log of negative number. If for some reason a firm has negative sales, the firm should be removed before we proceed with the calculation.[1]

$$MKTS_t = \sum_{i=1}^{n} ln(SALE_{it}) \tag{C.4}$$

C.2 Proxies for Rivalry

There are several accounting based metrics that provide a reasonable proxy for the level of rivalry among existing competitors. These measures tend to capture competition among rivals by focusing on market share. Highly concentrated industries, i.e., industries where fewer firms control a large market share, typically face lower existing competition. The two most common

[1] Some analysts, consider the MKTS as a proxy for rivalry among existing competitors.

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measures of concentration are the Herfindahl-Hirschman Index, also known as the HH Index, and the four-firm concentration ratio.

As a way of illustrating the calculation of the HH index and the four firm concentration ratio, consider the sales data shown in Table C.1. The table assumes that we have four different markets (monopoly with one firm, duopoly with two firms, oligopoly with three firms, and a perfectly competitive market with 20 firms). In all four markets the total volume of sales is the same (2000 units), and we assume that share of sales is equal among firms.

Firm Number	Monopoly	Duopoly	Oligopoly	Perf. Comp.
1st	2000	1000	500	100
2nd		1000	500	100
3rd			500	100
4th			500	100
5th				100
...				...
20th				100
Industry Sales	2000	2000	2000	2000

Table C.1: Sales Data - Different Markets

The HH Index is measured as the sum of *squared market shares* of all firms in an industry (equation C.5).

$$HHIndex_t = \sum_{i=1}^{n} \left(\frac{SALE_{it}}{\sum_{i=1}^{n} SALE_{it}} \right)^2 \tag{C.5}$$

where

- $SALE_{it}$ reflects sales of firm i in period t.
- $\sum_{i=1}^{n} SALE_{it}$ captures sum (total) sales of all n firms in the industry.
- The fraction $SALE_{it}/(\sum_{i=1}^{n} SALE_{it})$ captures the market share of firm i in period t.

Table C.2, shows the process of calculating the HH index based on the sales data from the previous table. The data points in each row of Table C.2 show the squared market share for each firm. The bottom line of the table shows the sum of squared market shares across all firms in the industry, i.e., the $HHIndex_t$.

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As we can see, if there is only one firm in the industry the HH index takes the value of 1. If the market is shared between two similar size firms the value of the index becomes 0.5. The value of the HH index decreases as the market is divided by a growing number of similarly sized firms. In our case it takes the value of 0.05 when there 20 firms in the industry.

Firm Number	Monopoly	Duopoly	Oligopoly	Perf. Comp.
1st	1	0.25	0.0625	0.0025
2nd		0.25	0.0625	0.0025
3rd			0.0625	0.0025
4th			0.0625	0.0025
5th				0.0025
	...			...
20th				0.0025
HH Index	1	0.5	0.25	0.05

Table C.2: HH Index Across Different Markets

The four-firm concentration ratio (equation C.6) is measured as the *sum of market shares of the four largest firms* in an industry.

$$CON4_t = \sum_{i=1}^{4} \left(\frac{SALE_{it}}{\sum_{i=1}^{n} SALE_{it}} \right) \tag{C.6}$$

where

- $SALE_{it}$ reflects sales of firm i in period t.
- $\sum_{i=1}^{n} SALE_{it}$ captures sum (total) sales of all n firms in the industry.
- The fraction $SALE_{it}/(\sum_{i=1}^{n} SALE_{it})$ captures the market share of firm i in period t.
- Notice that the summation extends to the four largest firms.

Table C.3, shows the process of calculating the four firm concentration ratio based on the sales data from table C.1. The data points in each row of Table C.3 show the market share, i.e., $SALE_{it}/(\sum_{i=1}^{n} SALE_{it})$ for each firm. The bottom line of the table shows the sum of market shares across the four largest firms in the industry.

As shown in Table C.3, its highest value is 1 for a monopoly or a market dominated by up to four major players, but it drops as the number of firms in the industry increases.

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Firm Number	Monopoly	Duopoly	Oligopoly	Perf. Comp.
1st	1	0.5	0.25	0.05
2nd		0.5	0.25	0.05
3rd			0.25	0.05
4th			0.25	0.05
Concentration Ratio	1	1	1	0.2

Table C.3: Four Firm Concentration Ratios

There are two more measures of rivalry among existing competitors: total number of firms in the industry, and product market size. The former, as the name indicates, simply counts the number of firms in a market. Think of the two extreme scenarios in terms of number of firms in a market: monopoly with just one company and perfect competition with a very large number of firms.

The second measure of rivalry, product market size, is measured as the natural log of industry aggregate sales, and it is likely to be positively associated with existing competition for two reasons: First, aggregate sales are positively associated with the number of firms in the market. Second, large market demand attracts more entrants, which would in turn lead to more firms competing in the same product market.

C.3 Product Substitution Proxies

There are no well developed product substitution proxies. Theoretically, it has been argued that higher the product substitutability the greater the intensity of price based competition, and price-cost margin as a proxy for product substitutability [74].

- **Price-cost margin (PCM)** It is calculated as the fraction of industry level of sales over industry level of operating costs. While sales are available in Compustat (SALE), the operating cost is derive as follows: Operating costs = Cost of goods sold (Compustat code= COGS) plus selling, general and administrative expenses (Compustat code= XSGA) plus depreciation and amortization (Compustat code=DP). $OC_{it} = COGS_{it} + XSGA_{it} + DP_{it}$. Based on this we calculate PCM_t as follows:

$$PCM_t = \frac{\sum_{i=1}^{n} SALE_{it}}{\sum_{i=1}^{n} OC_{it}} \tag{C.7}$$

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The main problem with this proposed proxy is endogeneous. Our goal is to establish the effect of industry structure on profitability. However, the variable used to capture industry structure ($PCM_t = Sales/OperatingCost$) is very similar to the profitability measure. One can convert PCM_t to a profit margin by simply subtracting one. $(\frac{Sales}{OperatingCost})-1 = ProfitMargin)$.

- **A point elasticity of substitution (ϵ)** This is based on the idea of an instantaneous rate of growth for sales and operating costs. Therefore

$$\epsilon_{it} = \frac{ln(SALE_{it}) - ln(SALE_{it-1})}{ln(OC_{it}) - ln(OC_{it-1})} \tag{C.8}$$

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Appendix D

Wireless Market: US versus Canada

D.1 Extracting Compustat Data

In order to generate the data set used for this tutorial you will have to extract the following data from Compustat:

1. Select the period 1995 to 2015
2. Select the entire database
3. Deselect all output options (right column) from Screening Variables.
   - Make sure that CAD remains selected, otherwise Canadian companies will not be included.
4. Under constraints select that the GIC Group equals 5010.
5. Under variable selection, we are going to select the following variables:
   (a) ticker symbol
   (b) GIC group (ggroup)
   (c) headquarter location (loc)
   (d) assets (at)
   (e) capital expenditures (capx)
   (f) cost of goods sold (cogs)
   (g) income before extraordinary items (ib)

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(h) net income (ni)
(i) operating income before depreciation (oibdp)
(j) property plant and equipment (ppent)
(k) sales (sale)
(l) research and development expenses (xrd)

Save your output as csv file.

D.2 Rivalry Among Existing Competitors

We start by loading the libraries needed for this script, setting the working directory and importing the csv that contains the Compustat data.

```
> library(data.table)
> library(psych) # for detailed descriptive statistics
> library(ggplot2)# for making graphs
> library(dplyr) # for generating the four firm concentration ratio
> library(gridExtra) for combining graphs
> options(scipen = 99) # to avoid scientific notation
> dt  <- fread("gicg5010_4indStructure2.csv")
> head(dt)

   gvkey datadate fyear  tic        at      capx      cogs
1:  1164 19951231  1995 MCIP  6634.571   355.841  1992.413
2:  1164 19961231  1996 MCIP 19861.977   657.061  2457.102
3:  1164 19971231  1997 MCIP 22389.553  2644.915  3791.599
4:  1164 19981231  1998 MCIP 86401.000  5418.000  8416.000
5:  1164 19991231  1999 MCIP 91072.000  8716.000 15951.000
6:  1164 20001231  2000 MCIP 85893.000 10984.000  8745.000
          ib        ni     oibdp     ppent      sale xrd ggroup
1:   267.660   267.660   987.313  1569.332  3639.875  NA   5010
2: -2188.944 -2213.378  1199.355  3897.124  4485.130  NA   5010
3:   383.652   383.652  2019.327  5992.986  7351.354  NA   5010
4: -2558.000 -2687.000  4950.000 24307.000 17678.000  NA   5010
5:  3950.000  3950.000 12234.000 28618.000 37120.000  NA   5010
6:  2609.000  2534.000  8754.000 35177.000 22755.000  NA   5010
   loc
1: USA
2: USA
```


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```
3: USA
4: USA
5: USA
6: USA
```

Since our objective is to compare the rivalry between US and Canada, we are going to use the variable `loc` to limit our data set to companies with headquarters either in US or Canada.

```
> dt <- dt[dt$loc=="USA" | dt$loc=="CAN",]
```

It is possible that there are a few data points from 1994. We can see how many data we have from 1994 creating a quick table and then delete them.

```
> table(dt$fyear)

1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006
  19  251  264  269  273  265  256  217  194  180  164  148  128
2007 2008 2009 2010 2011 2012 2013 2014 2015
 111   99   93   84   76   75   70   60   50

> dt <- dt[dt$fyear>=1995,]
```

All three proxies considered for rivalry among existing competitors are based on sales data therefore we need to start by cleaning our sales data.

```
> dt$sale <- ifelse(dt$sale<=0,NA,dt$sale)
```

D.2.1 Generate Total Sales & Market Share

Recall from the discussion in Appendix C, that both HH Index and four firm concentration ratio are based on market share of individual firms. To generate a firm's market share we need to start by calculating the total sales in the industry level by location (loc) and fiscal year (fyear). We do this using `aggregate` function to group by loc and fyear. Within each group we calculate the total using the argument `sum` and save the output in a new data frame named `dt1`.

```
> dt1 <- data.frame(aggregate(sale~loc+fyear, data=dt, FUN=sum))
> dt1[1:5,]
```


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```
  loc fyear      sale
1 CAN  1995  44951.32
2 USA  1995 349146.37
3 CAN  1996  50378.54
4 USA  1996 345348.90
5 CAN  1997  59095.73
```

Notice that our new aggregate variable is still named `sale`. To avoid confusion we are going to rename this `sale_locYear`.

```
> names(dt1)[3] <- "sale_locYear"
> names(dt1)
```

```
[1] "loc"          "fyear"        "sale_locYear"
```

To create the market share we need to have total sales for the year next to each company, therefore we need to merge the new data with the existing data set. Notice that we need to match based on two variables: loc and fyear.

```
> dt <- merge(dt, dt1, by=c("loc","fyear"))
> names(dt)
```

```
 [1] "loc"          "fyear"        "gvkey"        "datadate"
 [5] "tic"          "at"           "capx"         "cogs"
 [9] "ib"           "ni"           "oibdp"        "ppent"
[13] "sale"         "xrd"          "ggroup"       "sale_locYear"
```

After the merging, we remove extra variables to make the data set more manageable. We can also remove dt1.

```
> dt <- dt[,c(1:3, 5, 13,16)]
> rm(dt1)
```

For the creation of the HH index we need the squared market share, while for the creation of the four firm concentration ratio, we need the simple market share of each firm. With the following two lines of script we generate these two new variables: market share and market share squared per location and year.

```
> dt$MShare <- dt$sale/dt$sale_locYear
> dt$SqMShare <- dt$MShare^2
```


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D.2.2 HH Index

To generate the HH index by location (loc) and year, we use the same approach as the one above for sale_locYear. We use the aggregate function and we indicate that we want to total (sum) of all squared market shares in each locations and each year.

```
> dt2 <- data.frame(aggregate(SqMShare~loc+fyear, data=dt, FUN=sum))
> names(dt2)

[1] "loc"      "fyear"    "SqMShare"
```

Noticing that the new variable has the old name, we rename it to capture the fact that it provides the HH index by location and by year as HH_locYear. Subsequently we merge it with our data set and remove the temporary data set (dt2)

```
> names(dt2)[3] <-  "HH_locYear"

> dt <- merge(dt, dt2, by=c("loc", "fyear"))
> names(dt)

 [1] "loc"          "fyear"        "gvkey"        "datadate"
 [5] "tic"          "at"           "capx"         "cogs"
 [9] "ib"           "ni"           "oibdp"        "ppent"
[13] "sale"         "xrd"          "ggroup"       "sale_locYear"
[17] "MShare"       "SqMShare"     "HH_locYear"

> dt[1:3,c(1:2,5,13,16:19)]

   loc fyear  tic    sale sale_locYear    MShare    SqMShare
1: CAN  1995  BCE 24624.0     44951.32 0.5477926 0.300076748
2: CAN  1995 BCE1  8183.4     44951.32 0.1820503 0.033142304
3: CAN  1995   TU  2399.2     44951.32 0.0533733 0.002848709

   HH_locYear
1:   0.342594
2:   0.342594
3:   0.342594

> rm(dt2)
```


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D.2.3 Four Firm Concentration Ratio

The creation of the four firm concentration ratio is bit more complicated. It requires that we identify the four largest firms in each country and in each year. Luckily an anonymous good Samaritan has developed the following script that we can use.[1] The script mutates (i.e., introduces a new variable) called *TOP4*. The variable takes the value of market share (*MShare*) if the firm's market share is in the group of top four firms when grouped by location and year. Else it takes the value of zero.

```
> dt <- dt %>% group_by(loc, fyear) %>% mutate(
+     TOP4 = ifelse(row_number(desc(MShare)) <= 4, MShare, 0))
> dt3 <- data.frame(aggregate(TOP4~loc+fyear, data=dt, FUN=sum))
> names(dt3)

[1] "loc"   "fyear" "TOP4"

> names(dt3)[3] <-  "CON4"
> dt3[1:5,]

  loc fyear      CON4
1 CAN  1995 0.8431362
2 USA  1995 0.3801185
3 CAN  1996 0.8312716
4 USA  1996 0.3215791
5 CAN  1997 0.8104938
```

Once the data set has been created we can merge it with the existing data and remove dt3.

```
> dt <- merge(dt, dt3, by=c("loc", "fyear"))
> names(dt)

 [1] "loc"          "fyear"        "gvkey"        "tic"
 [5] "sale"         "sale_locYear" "MShare"       "SqMShare"
 [9] "HH_locYear"   "TOP4"         "CON4"
```

[1] The script uses the notation % > %. This is known as the chain notation and it is used heavily in the package `dplyr`. The expression `dt %>% head() %>% summary()` is equivalent to `summary(head(dt))` Source: https://stackoverflow.com/questions/24536154/what-does-mean-in-r

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```
\begin{Soutput}
 [1] "loc"          "fyear"        "gvkey"        "datadate"
 [5] "tic"          "at"           "capx"         "cogs"
 [9] "ib"           "ni"           "oibdp"        "ppent"
[13] "sale"         "xrd"          "ggroup"       "sale_locYear"
[17] "MShare"       "SqMShare"     "HH_locYear"   "TOP4"
[21] "CON4"
\end{Soutput}
\begin{Sinput}
> dt[1:3,c(1:2,5,19:21)]

  loc fyear  tic HH_locYear      TOP4      CON4
1 CAN  1995  BCE   0.342594 0.5477926 0.8431362
2 CAN  1995 BCE1   0.342594 0.1820503 0.8431362
3 CAN  1995   TU   0.342594 0.0533733 0.8431362

> rm(dt3)
```

D.2.4 Market Size Adjusted Number of Firms

Looking at the number of firms in each country does not provide a good measure of comparison across countries because the US market is much larger than the Canadian market. Therefore we need to proceed in the calculation in two stages. First calculate the number of firms and then divide this total market sales.

```
> dt4 <- data.frame(aggregate(sale~loc+fyear, data=dt,
         FUN=length))
> names(dt4)[3] <-  "rawNUM"
> dt <- merge(dt, dt4, by=c("loc", "fyear"))
> dt$NUM <- dt$rawNUM/(dt$sale_locYear)
> names(dt)

 [1] "loc"          "fyear"        "gvkey"        "datadate"
 [5] "tic"          "at"           "capx"         "cogs"
 [9] "ib"           "ni"           "oibdp"        "ppent"
[13] "sale"         "xrd"          "ggroup"       "sale_locYear"
[17] "MShare"       "SqMShare"     "HH_locYear"   "TOP4"
[21] "CON4"         "rawNUM"       "NUM"

> dt[1:3, c(1:3,19:23)]
```


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```
  loc fyear gvkey HH_locYear      TOP4      CON4 rawNUM
1 CAN  1995  2137   0.342594 0.5477926 0.8431362     20
2 CAN  1995  2141   0.342594 0.1820503 0.8431362     20
3 CAN  1995  2408   0.342594 0.0533733 0.8431362     20

           NUM
1 0.0004449258
2 0.0004449258
3 0.0004449258

> rm(dt4)
```

D.2.5 Generate Graphs

We start by plotting the HH index. Please notice that the HH_locYear takes one value per year for each country. Using the geom_line(), we can specify that we want a separate line for each country.

```
> HH.g  <- ggplot(dt, aes(x=fyear, y=HH_locYear))+
+     geom_line(aes(color=loc), size=1)+
+     xlab("Year") + ylab("HH Index")
> HH.g
```

We repeat with the four firm concentration ratio.

```
> CON4.g  <- ggplot(dt, aes(x=fyear, y=CON4))+
+     geom_line(aes(color=loc), size=1)+
+     xlab("Year") + ylab("Four Firm Concentration Ratio")
> CON4.g
```

We finish with the number of firms and arrange all three graphs in one Figure D.1.

```
> NUM.g  <- ggplot(dt, aes(x=fyear, y=NUM))+
+     geom_line(aes(color=loc), size=1)+
+     xlab("Year") + ylab("Number of Firms")
> NUM.g
> grid.arrange(HH.g,CON4.g, NUM.g,ncol=3)
```

If we want to see more details in the x-axis:
`scale_x_continuous(breaks = (seq(min(dt$fyear), max(dt$fyear), by = 1)))`

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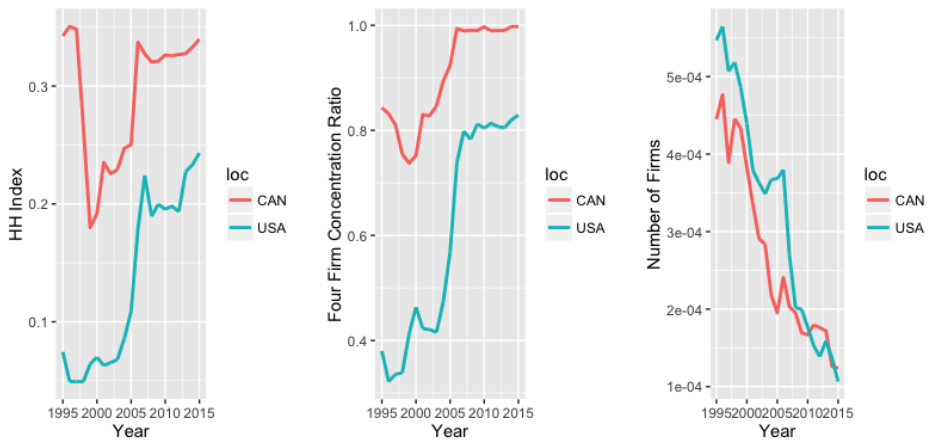

Figure D.1: Rivalry: Wireless Market US and Canada

If we want to change the color of our legend:
`scale_color_discrete(name = "Country")`

If we want to change the position of our legend:
`theme(legend.position = c(.1,.9))`

D.2.6 Questions

1. What does the HH index imply regarding rivalry among existing competitors between US and Canada?

2. What does the four firm concentration ratio imply for rivalry among existing competitors between US and Canada?

3. What has been the HH Index and four firm concentration ratio pattern since the beginning of the new millennium?

4. Looking at the number of firms (adjusted for size of the market), can we conclude that the differences in HH index and four firm concentration ratio are due to the relatively smaller size of the Canadian market?

D.3 Barriers to Entry

For the creation of barriers to entry we need to generate the market share of each firm and then use it to calculate the market share weighted measures.

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This means that the opening portion of the script is identical to the one for rivalry proxies. Notice that we are re-loadind the original Compustat data set.

As we have seen in Appendix C (p. 309), we can use the property plant and equipment, research and development expenditures, as well as capital expenditures to generate proxies for barriers to entry. These proxies are defined as the weighted average of corresponding measure based on all the firms in the industry.

We use the `aggregate` function to create the sum of weighted scores (market share time firm's corresponding financial data) as follows:

```
> dt5.1 <- data.frame(aggregate(c(ppent*MShare)~fyear+loc, data=dt, FUN=sum))
> names(dt5.1)[3] <- "INDPPENT"
> dt5.1[1:3,]

  fyear loc INDPPENT
1  1995 CAN 16007.81
2  1996 CAN 15926.96
3  1997 CAN 12880.01

> dt5.2 <- data.frame(aggregate(c(xrd*MShare)~fyear+loc, data=dt, FUN=sum))
> names(dt5.2)[3] <- "INDXRD"
> dt5.2[1:3,]

  fyear loc   INDXRD
1  1995 CAN 1182.470
2  1996 CAN 1397.293
3  1997 CAN 1643.487

> dt5.3 <- data.frame(aggregate(c(capx*MShare)~fyear+loc, data=dt, FUN=sum))
> names(dt5.3)[3] <- "INDCAPX"
> dt5.3[1:3,]

  fyear loc  INDCAPX
1  1995 CAN 1910.923
2  1996 CAN 2148.370
3  1997 CAN 2306.812
```

We merge the three data sets and combine them with the original data:

```
> dt5 <- merge(dt5.1, dt5.2, by=c("loc", "fyear" ))
>     dt5 <- merge(dt5, dt5.3, by=c("loc", "fyear" ))
> names(dt5)
```


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```
[1] "loc"      "fyear"    "INDPPENT" "INDXRD"   "INDCAPX"

> dt <- merge(dt, dt5, by=c("fyear", "loc"))
> names(dt)

 [1] "fyear"        "loc"          "gvkey"        "datadate"
 [5] "tic"          "at"           "capx"         "cogs"
 [9] "ib"           "ni"           "oibdp"        "ppent"
[13] "sale"         "xrd"          "ggroup"       "sale_locYear"
[17] "MShare"       "SqMShare"     "HH_locYear"   "TOP4"
[21] "CON4"         "rawNUM"       "NUM"          "INDPPENT"
[25] "INDXRD"       "INDCAPX"

> dt[1:3,c(1:2,5,24:26)]

  fyear loc  tic INDPPENT  INDXRD  INDCAPX
1  1995 CAN  BCE 16007.81 1182.47 1910.923
2  1995 CAN BCE1 16007.81 1182.47 1910.923
3  1995 CAN   TU 16007.81 1182.47 1910.923

>     rm(dt5.1, dt5.2, dt5.3, dt5)
```

We use the final data set to generate graphs for each one of the three proxies. All three graphs are shown in Figure **??**

```
> INDPPENT.g  <- ggplot(dt, aes(x=fyear, y=INDPPENT))+
+     geom_line(aes(color=loc), size=1)+xlab("Year") +
+     ylab("Weighted Average PP&E")
> INDPPENT.g
> INDXRD.g  <- ggplot(dt, aes(x=fyear, y=INDXRD))+
+     geom_line(aes(color=loc), size=1)+xlab("Year") +
+     ylab("Weighted Average R&D")
> INDXRD.g
> INDCAPX.g  <- ggplot(dt, aes(x=fyear, y=INDCAPX))+
+     geom_line(aes(color=loc), size=1)+xlab("Year") +
+     ylab("Weighted Average Capital Expenditures")
> INDCAPX.g
> grid.arrange(INDPPENT.g,INDXRD.g,INDCAPX.g, ncol=3)
```


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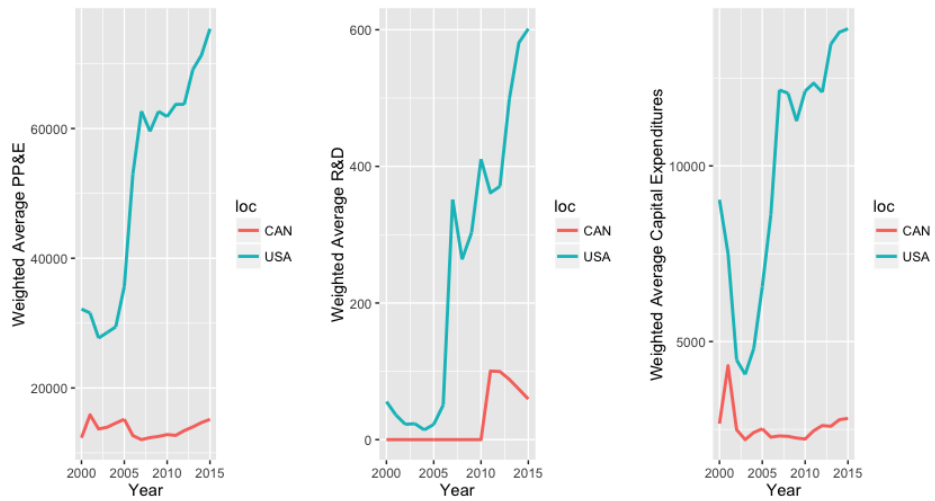

Figure D.2: Barriers to Entry: Wireless Market US and Canada

D.4 Profitability Comparison

In this last section, we are going to compare the average profitability between Canada and US.

```
> dt <- dt[dt$loc=="USA" | dt$loc=="CAN",]
> dt <- dt[dt$fyear>=2000,]
> dt$sale <- ifelse(dt$sale<=0,NA,dt$sale)
> dt$cogs <- ifelse(dt$cogs<=0,NA,dt$cogs)
> dt$pm <- dt$ib/dt$sale
> dt$om <- dt$oibdp/dt$sale
> dt$gm <- (dt$sale-dt$cogs)/dt$sale
```

For the rest of the discussion we are going to focus on gross profit margin (gm). We will examine descriptive statistics to evaluate the existence of outliers.

```
> describe(dt$gm)
```

```
   vars    n  mean    sd median trimmed  mad   min  max   range
X1    1 1819 -0.74 27.16   0.47    0.44 0.21 -1105 0.99 1105.99
     skew kurtosis   se
X1 -37.56  1504.62 0.64
```


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```
> hist(dt$gm)
```

The results indicate that there are outliers that we will remove from the comparison.

```
> dt$gm  <- ifelse(
        (
     dt$gm<(quantile(dt$gm,probs=c(.25),na.rm=T))
                -1.5*IQR(dt$gm,na.rm=T)|
     dt$gm>(quantile(dt$gm,probs=c(.75),na.rm=T))
                +1.5*IQR(dt$gm,na.rm=T)
    ),NA,dt$gm)
> describe(dt$gm)

   vars    n mean  sd median trimmed  mad   min  max range  skew
X1    1 1731 0.45 0.2   0.49    0.46 0.19 -0.16 0.99  1.15 -0.46
   kurtosis se
X1    -0.15  0

> hist(dt$gm)
> ggplot(dt, aes(factor(fyear), gm))+
     geom_boxplot(outlier.colour = "red", outlier.size = 2)
```

To compare between the two countries we need create a data set for US and another for Canada. We start by generating the data set for US.

```
> names(dt)

 [1] "fyear"        "loc"          "gvkey"        "datadate"
 [5] "tic"          "at"           "capx"         "cogs"
 [9] "ib"           "ni"           "oibdp"        "ppent"
[13] "sale"         "xrd"          "ggroup"       "sale_locYear"
[17] "MShare"       "SqMShare"     "HH_locYear"   "TOP4"
[21] "CON4"         "rawNUM"       "NUM"          "INDPPENT"
[25] "INDXRD"       "INDCAPX"      "pm"           "om"
[29] "gm"

> dtUS  <- dt[dt$loc=="USA",c(1:3,5, 27:29)]
> dtUS[1:5,]

     fyear loc gvkey  tic         pm         om        gm
1346  2000 USA  1164 MCIP  0.1146561 0.38470666 0.6156889
```


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```
1347  2000 USA  1318 AT.2  0.2781095 0.37083628 0.3708363
1348  2000 USA  1336  AT2  0.1146763 0.51781393 0.5178139
1349  2000 USA  1581  T.2  0.0707628 0.32695776 0.5285764
1350  2000 USA  1641 MOCC -0.0410294 0.04780443 0.2608135
```

In order to create the confidence interval we need to generate the mean, standard error, and number of observations.

```
> dtUS_gm <- describeBy(dtUS$gm, dtUS$fyear, mat=T)
> names(dtUS_gm)
```

```
 [1] "item"     "group1"   "vars"     "n"        "mean"
 [6] "sd"       "median"   "trimmed"  "mad"      "min"
[11] "max"      "range"    "skew"     "kurtosis" "se"
```

```
> dtUS_gm[1:5,c(2,3:5,15)]
```

```
    group1 vars   n      mean         se
X11   2000    1 183 0.3760414 0.01546279
X12   2001    1 162 0.3989072 0.01589547
X13   2002    1 147 0.4392309 0.01707822
X14   2003    1 136 0.4809754 0.01771686
X15   2004    1 130 0.4786936 0.01683395
```

Since the sample size for each year is large we will use z-score

```
> dtUS_gm$UL4_gm  <-
        dtUS_gm$mean+qnorm(.025, lower.tail = F)*dtUS_gm$se
> dtUS_gm$LL4_gm  <-
        dtUS_gm$mean-qnorm(.025, lower.tail = F)*dtUS_gm$se
> dtUS_gm <- dtUS_gm[,c(2,4:5,7,16:17)]
> dtUS_gm$loc  <- rep("US", nrow(dtUS_gm))
> dtUS_gm[1:5,]
```

```
   group1   n      mean    median    UL4_gm    LL4_gm loc
11   2000 183 0.3760414 0.3858389 0.4063479 0.3457349  US
12   2001 162 0.3989072 0.4341166 0.4300617 0.3677526  US
13   2002 147 0.4392309 0.4526546 0.4727035 0.4057582  US
14   2003 136 0.4809754 0.5164898 0.5156998 0.4462510  US
15   2004 130 0.4786936 0.5179039 0.5116875 0.4456996  US
```

We repeat exactly the same analysis for Canada.

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```
> names(dt)
\begin{Soutput}
 [1] "fyear"        "loc"          "gvkey"        "datadate"
 [5] "tic"          "at"           "capx"         "cogs"
 [9] "ib"           "ni"           "oibdp"        "ppent"
[13] "sale"         "xrd"          "ggroup"       "sale_locYear"
[17] "MShare"       "SqMShare"     "HH_locYear"   "TOP4"
[21] "CON4"         "rawNUM"       "NUM"          "INDPPENT"
[25] "INDXRD"       "INDCAPX"      "pm"           "om"
[29] "gm"
\end{Soutput}
\begin{Sinput}
> dtCAN  <- dt[dt$loc=="CAN",c(1:3,5, 27:29)]
> dtCAN[1:5,]

     fyear loc gvkey  tic         pm        om        gm
1323  2000 CAN  2137  BCE 0.04896651 0.3758705 0.3758705
1324  2000 CAN  2141 BCE1 0.11730915 0.4453515 0.4453515
1325  2000 CAN  2408   TU 0.07165952 0.3831375 0.3831375
1326  2000 CAN  7043 AIT. 0.09547221 0.3682017 0.3682017
1327  2000 CAN  9215  RCI 0.04036302 0.2618894 0.2618894

> dtCAN_gm <- describeBy(dtCAN$gm, dtCAN$fyear, mat=T)
> names(dtCAN_gm)

 [1] "item"     "group1"   "vars"     "n"        "mean"
 [6] "sd"       "median"   "trimmed"  "mad"      "min"
[11] "max"      "range"    "skew"     "kurtosis" "se"

> dtCAN_gm[c(2,3:5,15)]

    group1 vars  n      mean         se
X11   2000    1 20 0.2829519 0.03051942
X12   2001    1 18 0.3554872 0.04007081
X13   2002    1 15 0.3721423 0.04762140
X14   2003    1 16 0.4272210 0.05864285
X15   2004    1 12 0.4748534 0.07456941
```

Since the sample size for each year is small we will use t-score.

```
> dtCAN_gm$UL4_gm  <- dtCAN_gm$mean+qt(.025,
         dtCAN_gm$n-1,lower.tail = F)*dtCAN_gm$se
```


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```
> dtCAN_gm$LL4_gm  <- dtCAN_gm$mean-qt(.025,
         dtCAN_gm$n-1,lower.tail = F)*dtCAN_gm$se
> dtCAN_gm <- dtCAN_gm[,c(2,4:5,7,16:17)]
> dtCAN_gm$loc <- rep("CAN",nrow(dtCAN_gm))
> dtCAN_gm[1:5,]
```

```
   group1  n      mean    median    UL4_gm    LL4_gm loc
11   2000 20 0.2829519 0.2749513 0.3468297 0.2190740 CAN
12   2001 18 0.3554872 0.3478096 0.4400292 0.2709451 CAN
13   2002 15 0.3721423 0.3737512 0.4742801 0.2700046 CAN
14   2003 16 0.4272210 0.4032155 0.5522153 0.3022268 CAN
15   2004 12 0.4748534 0.3957319 0.6389796 0.3107272 CAN
```

Using the `rbind`

In our problems so far we have been using the function `merge` to merge, i.e., position data set next to each other based on one or more common variables. A problem with this approach is that the data set spreads to the right and we have to rename the variables in order to keep track of what variable is for what data. An alternative is to append the data, i.e., position the new data at the bottom of the existing one using the function `rbind`. For this to work the data set must have exactly the same variables (names of variables must be identical). You can think of the `rbind` as a way of making panel data by combining time series data or creating panel data by combining cross section data.

Since both US and Canadian data sets have exactly the same variables, we can combine the two data set by simply adding their rows.

```
> dtUSvCAN  <- rbind(dtUS_gm, dtCAN_gm)
> head(dtUSvCAN,3)
```

```
    group1   n      mean    median    UL4_gm    LL4_gm loc
X11   2000 183 0.3760414 0.3858389 0.4063479 0.3457349  US
X12   2001 162 0.3989072 0.4341166 0.4300617 0.3677526  US
X13   2002 147 0.4392309 0.4526546 0.4727035 0.4057582  US
```

```
> tail(dtUSvCAN,3)
```

```
      group1 n      mean    median    UL4_gm    LL4_gm loc
X1141   2013 8 0.4827252 0.4305820 0.7253440 0.2401064 CAN
X1151   2014 6 0.4658077 0.4240841 0.6305192 0.3010962 CAN
X1161   2015 6 0.4802786 0.4478542 0.6388530 0.3217042 CAN
```


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We use the new data set to generate the graph comparing the average gross profit margin in US and in Canada. The output is shown in Figure D.3.

- Examine the pattern. Does it indicate that the average profitability differ between US and Canada? Can you think of a plausible explanation of the pattern during the financial crisis?
- Can we assess if the differences are statistically significant?
- What do you need to make this assessment?

```
> plot_gm  <- ggplot(dtUSvCAN, aes(x = group1, y=mean, color=loc)) +
+     geom_point(size = 4) + geom_line(aes(group=loc))+
+     ylab("Average Gross Profit Margin")+xlab("Year")+
+     theme(legend.position=c(.1,.9))
```

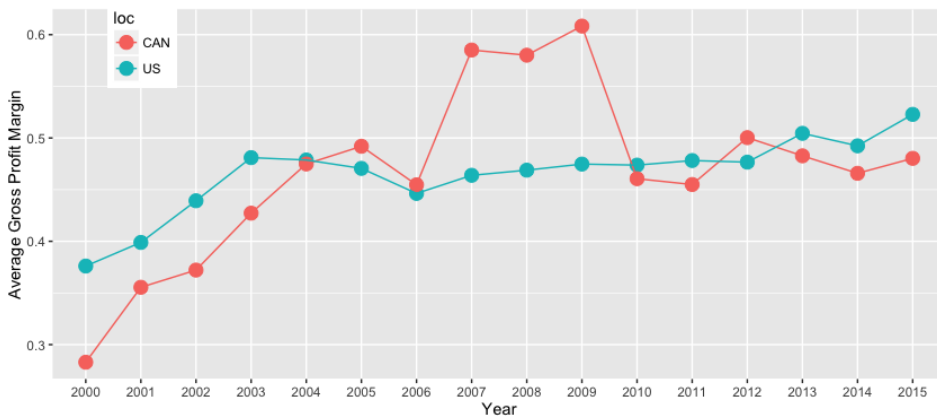

Figure D.3: Average Gross Margin: Wireless Market US and Canada

We continue by creating the graph showing just the boundaries of 95% confidence interval. The output is shown in Figure D.4. Look carefully at the pattern. Does it indicate that the average profitability differ between US and Canada? Can we assess if the differences are statistically significant?

- If the two confidence intervals overlap this means that the differences are not significant. In other words the average profitability in one country does not differ from the average profitability in the second country.

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- What is your assessment regarding the average profitability between the two countries?
- What does this mean regarding the industry structure?
- Why do you think the limits of the CI are wider in Canada versus US? *Hint*: Look at the formula for the confidence interval and think what determines the limits.

```
> plot_gm_CI <- ggplot(dtUSvCAN, aes(x = group1, color=loc)) +
+     geom_errorbar(aes(ymax = UL4_gm, ymin = LL4_gm))+
+     ylab("Gross Profit Margin - 95% Confidence Interval")+
        xlab("Year")+
+     theme(legend.position=c(.1,.9))
```

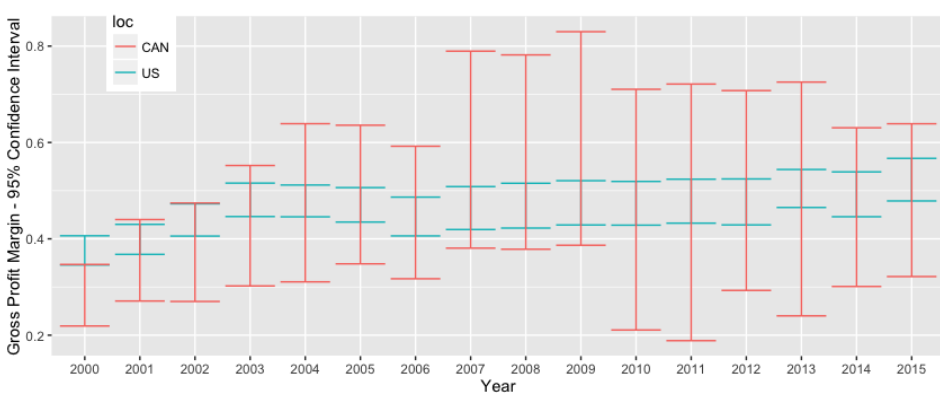

Figure D.4: 95% Confidence Interval for Average Gross Margin: Wireless Market US and Canada

Finally, we bring the two graphs next to each by leveraging the package grid.extra. The output is shown in Figure D.5

```
> grid.arrange(plot_gm,plot_gm_CI, ncol=2)
```

D.5 Questions

1. Replicate the profitability analysis using profit margin (PM) and operating margin (OM).[2]

[2]See p. 303 for formulas of PM and OM.

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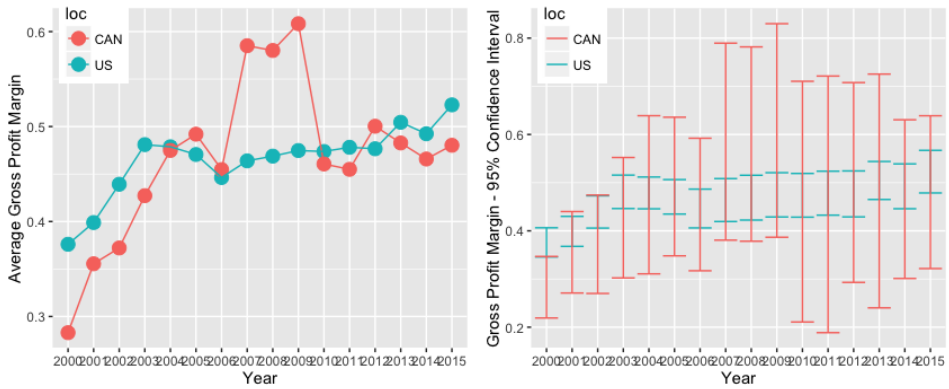

Figure D.5: Gross Margin: Wireless Market US and Canada

2. Create a subset based on the top 3 Canadian firms.[3]

   (a) Generate descriptive statistics for gross margin by year and save the data in a data set named *dt4top3_ds*.

   (b) How many observations do you have for each year in *dt4top3_ds*?

   (c) Given the small number of observations it does not make sense to create confidence intervals. However, if we want to combine (`rbind`) the new data sets with the existing US data, we need to have the same variables and variable names. Create the variable *UL4_gm* and set it equal to the median. Repeat with the variable *LL4_gm*. Populate the variable *loc* with the value *CAN_T3*.

   (d) Create a new data set *dtUSvCAN_T3* that combines *dtUS_gm* and *dt4top3_ds*.

   (e) Generate the graph showning the mean of Canadian top 3 to US industry mean.

   (f) Generate a graph that shows the upper and lower limit of Canadian top 3 (recall that this is set to the median) and the confidence interval of US industry mean.

   (g) Summarize your findings.

[3]The R script for this problem is on p. 334.

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Performance of Top 3 Canadian Firms

```
> names(dt)

 [1] "fyear"        "loc"          "gvkey"        "datadate"
 [5] "tic"          "at"           "capx"         "cogs"
 [9] "ib"           "ni"           "oibdp"        "ppent"
[13] "sale"         "xrd"          "ggroup"       "sale_locYear"
[17] "MShare"       "SqMShare"     "HH_locYear"   "TOP4"
[21] "CON4"         "rawNUM"       "NUM"          "INDPPENT"
[25] "INDXRD"       "INDCAPX"      "pm"           "om"
[29] "gm"

> dt4top3 <- dt[dt$loc=="CAN" &
     c(dt$tic=="BCE"|dt$tic=="TU"|dt$tic=="RCI"),c(1:3,5, 27:29)]
> dt4top3[1:10,]

     fyear loc gvkey tic          pm        om        gm
1323  2000 CAN  2137 BCE  0.04896651 0.3758705 0.3758705
1325  2000 CAN  2408  TU  0.07165952 0.3831375 0.3831375
1327  2000 CAN  9215 RCI  0.04036302 0.2618894 0.2618894
1579  2001 CAN  2137 BCE  0.11141818 0.3448943 0.3448943
1581  2001 CAN  2408  TU -0.01927082 0.3512065 0.3512065
1583  2001 CAN  9215 RCI -0.11099647 0.2262913 0.2262913
1796  2002 CAN  2137 BCE  0.09601376 0.3862809 0.3862809
1798  2002 CAN  2408  TU -0.03241183 0.3594559 0.3594559
1800  2002 CAN  9215 RCI  0.07217875 0.2527052 0.2527052
1990  2003 CAN  2137 BCE  0.09681990 0.3805101 0.3805101

> dt4top3_ds <- describeBy(dt4top3$gm, dt4top3$fyear, mat = T)
> dt4top3_ds$UL4_gm  <- dt4top3_ds$median
> dt4top3_ds$LL4_gm  <- dt4top3_ds$median
> dt4top3_ds$loc <- rep("CAN_T3",nrow(dt4top3_ds))
> names(dt4top3_ds)

 [1] "item"     "group1"   "vars"     "n"        "mean"
 [6] "sd"       "median"   "trimmed"  "mad"      "min"
[11] "max"      "range"    "skew"     "kurtosis" "se"
[16] "UL4_gm"   "LL4_gm"   "loc"

> dt4top3_ds <- dt4top3_ds[,c(2,4:5,7,16:18)]
> names(dt4top3_ds)
```


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```
[1] "group1" "n"      "mean"   "median" "UL4_gm" "LL4_gm"
[7] "loc"

> dtUSvCAN_T3  <- rbind(dtUS_gm, dt4top3_ds)
> head(dtUSvCAN_T3,3)

    group1   n      mean    median    UL4_gm    LL4_gm loc
X11   2000 183 0.3760414 0.3858389 0.4063479 0.3457349  US
X12   2001 162 0.3989072 0.4341166 0.4300617 0.3677526  US
X13   2002 147 0.4392309 0.4526546 0.4727035 0.4057582  US

> tail(dtUSvCAN_T3,3)

      group1 n      mean    median    UL4_gm    LL4_gm    loc
X1141   2013 3 0.4097568 0.3893436 0.3893436 0.3893436 CAN_T3
X1151   2014 3 0.4100117 0.3922957 0.3922957 0.3922957 CAN_T3
X1161   2015 3 0.4046477 0.3766960 0.3766960 0.3766960 CAN_T3

> plot_gm_T3  <- ggplot(dtUSvCAN_T3, aes(x = group1, y=mean, color=loc)) +
     geom_point(size = 4) + geom_line(aes(group=loc))+
     ylab("Average Gross Profit Margin")+xlab("Year")+
     theme(legend.position=c(.1,.9))
> plot_gm_CI_T3 <- ggplot(dtUSvCAN_T3, aes(x = group1, color=loc)) +
     geom_errorbar(aes(ymax = UL4_gm, ymin = LL4_gm))+
     ylab("Gross Profit Margin - 95% Confidence Interval")+xlab("Year")+
     theme(legend.position=c(.1,.9))
> grid.arrange(plot_gm_T3,plot_gm_CI_T3, ncol=2)
>
>
```


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Appendix E

WHR ERP Payoffs

E.1 Load and Review Data

```
> library(data.table) # for fast loading of csv data
> library(plm) # for working with panel data
> library(psych) # for descriptive statistics by group
> library(ggplot2) # for making graphs
> library(gridExtra) # for combining multiple graphs
> dt<-fread("WHR_ERPPayoffs.csv")
> dt<-dt[dt$fyear<=2010,]
> names(dt)
```

```
 [1] "gvkey"    "datadate" "fyear"    "tic"      "ap"
 [6] "at"       "ceq"      "cogs"     "csho"     "emp"
[11] "ib"       "intan"    "invt"     "oibdp"    "ppent"
[16] "recd"     "rect"     "sale"     "xad"      "xsga"
[21] "prcc_c"   "ggroup"
```

E.2 Work with Panel Data

Panel data is a combination of cross-sectional and time-series data.[1] The dataset contains multiple subjects (e.g., firms, customers, employees) and each one of them is followed over several periods. For example, a dataset that contains stock market data for Apple and Blackberry over the period 2000 to 2016 is panel data. The dataset, we extracted from Compustat for analyzing the WHR ERP payoffs is panel data. It contains financial data for

[1] Panel data is also known as longitudinal or cross-sectional time-series.

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all firms in a specific industry over several years. Working with panel data is very useful because they allow a dual reference point. Panel data allow us follow the performance of a company over time and run a year-by-year comparison to its key competitors or the entire industry.

E.2.1 Lag Values in Panel Data

For the creation of ROA we need to generate the average of total assets, which means that we need lagged values of total assets. To create lags for all firms, we need to declare that our dataset is in the form of panel data (cross-sectional time-series) and leverage the functionality of the `plm` package,, which is designed to work with panel data.

For R this means that the first variable in the dataset has to be the one that captures the cross-sectional aspect of the dataset (gvkey is a unique identifier of each firm), and the second variable must capture the time series aspect of the dataset (fyear captures the time aspect and repeats consistently for all firms).[2] This means that we will have to remove the second variable from the dataset using the [row, column] approach (i.e., `dt[,-2]`)

```
> dt<-dt[,-2]
> dt<-pdata.frame(dt)
> dt$sale<-ifelse(dt$sale<=0,NA,dt$sale)
> dt$cogs<-ifelse(dt$cogs<=0,NA,dt$cogs)
> dt$at<-ifelse(dt$at<=0, NA, dt$at)
> dt$at_lag<-lag(dt$at)
> dt$at_avg<-(dt$at+dt$at_lag)/2
> dt$om<-dt$oibdp/dt$sale
> dt$ato<-dt$sale/dt$at_avg
> dt$roa<-dt$oibdp/dt$at_avg
> dt$invdays<-(dt$invt/dt$cogs)*365
> names(dt)
```

```
 [1] "gvkey"   "fyear"   "tic"     "ap"      "at"      "ceq"
 [7] "cogs"    "csho"    "emp"     "ib"      "intan"   "invt"
[13] "oibdp"   "ppent"   "recd"    "rect"    "sale"    "xad"
[19] "xsga"    "prcc_c"  "ggroup"  "at_lag"  "at_avg"  "om"
[25] "ato"     "roa"     "invdays"
```

```
> dt[1:5, c(2,3, 24:27)]
```

[2] datadate is not a good variable to capture the time aspect of the dataset because different firms have different month for the end of their fiscal year.

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```
          fyear  tic         om      ato        roa  invdays
1109-1993  1993 WAFR 0.05495584       NA         NA 193.8156
1109-1994  1994 WAFR 0.06343689 1.364863 0.08658265 183.9682
1109-1995  1995 WAFR 0.05540368 1.530117 0.08477412 137.3859
1109-1996  1996 WAFR 0.05363229 1.465948 0.07862214 124.2093
1109-1997  1997 WAFR 0.05763984 1.275060 0.07349424 130.5632
```

E.3 Set Aside WHR from Competitors Data

Our objective is to compare WHR versus its competitors. This means that we need to create two separate data sets. One for WHR and one for all of its competitors.

```
> dt_whr<-dt[dt$tic=="WHR",c(1:3,24:27)]
> dt<-dt[!dt$tic=="WHR",]
```

Generate summary stats for target variables.

```
> describe(dt[,c(24:27)])
```

```
        vars    n   mean     sd median trimmed   mad      min
om         1 6684  -1.12  40.19   0.08    0.08  0.07 -2915.00
ato        2 5958   1.48   1.05   1.36    1.40  0.56     0.00
roa        3 6002  -0.19  12.51   0.11    0.10  0.11  -898.28
invdays    4 6704 159.04 749.13 100.32  110.19 59.39     0.00

             max    range   skew kurtosis   se
om          0.88  2915.88 -62.29  4288.03 0.49
ato        57.16    57.16  25.70  1326.77 0.01
roa         1.45   899.73 -64.95  4504.69 0.16
invdays 42987.05 42987.05  42.13  2078.83 9.15
```

Results show that there are extreme outliers. (*How do we know that there are outliers?*)

E.3.1 Remove Outliers

We remove oulliers using the interquartile range.

```
> dt$om <-ifelse((
     dt$om<(quantile(dt$om,probs=.25,na.rm=T))-
```


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```
        1.5*IQR(dt$om,na.rm=T)|
     dt$om>(quantile(dt$om,probs=.75,na.rm=T))+
        1.5*IQR(dt$om,na.rm=T)
     ),NA,dt$om)
> dt$ato<-ifelse((
     dt$ato<(quantile(dt$ato,probs=.25,na.rm=T))-
        1.5*IQR(dt$ato,na.rm=T)|
     dt$ato>(quantile(dt$ato,probs=.75,na.rm=T))+
        1.5*IQR(dt$ato,na.rm=T)
     ),NA,dt$ato)
> dt$roa<-ifelse((
     dt$roa<(quantile(dt$roa,probs=.25,na.rm=T))-
        1.5*IQR(dt$roa,na.rm=T)|
     dt$roa>(quantile(dt$roa,probs=.75,na.rm=T))+
        1.5*IQR(dt$roa,na.rm=T)
     ),NA,dt$roa)
> dt$invdays<-ifelse((
     dt$invdays<(quantile(dt$invdays,probs=.25,na.rm=T))-
        1.5*IQR(dt$invdays,na.rm=T)|
     dt$invdays>(quantile(dt$invdays,probs=.75,na.rm=T))+
        1.5*IQR(dt$invdays,na.rm=T)
     ),NA,dt$invdays)
> describe(dt[,c(24:27)])

        vars    n   mean    sd median trimmed   mad   min    max
om         1 5937   0.09  0.07   0.09    0.09  0.06 -0.12   0.28
ato        2 5704   1.37  0.57   1.34    1.36  0.53  0.00   2.92
roa        3 5407   0.11  0.11   0.12    0.12  0.09 -0.18   0.39
invdays    4 6197 104.40 58.36  95.24  100.12 52.24  0.00 283.42

         range  skew kurtosis   se
om        0.41 -0.21     0.32 0.00
ato       2.92  0.24    -0.01 0.01
roa       0.58 -0.20     0.25 0.00
invdays 283.42  0.69     0.24 0.74
```

E.3.2 Benchmark Competitors Performance

To evaluate how WHR has done versus its competitors we need to establish a benchmark of competitors performance. A benchmark that we can use is

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the 95% confidence interval for each target variable. This means that we are going to calculate the 95% confidence limits (upper and lower limits) around the mean value of each target variable. For example, working with operating margin, we will find the average value based on data from all competitors and create a confidence interval as follows:

CI for Competitors Operating Margin

```
> dt_om<-describeBy(dt$om, dt$fyear, mat=T)
> dt_om$UL4_om<-dt_om$mean+qnorm(.025,lower.tail=F)*dt_om$se
> dt_om$LL4_om<-dt_om$mean-qnorm(.025,lower.tail=F)*dt_om$se
> setnames(dt_om, old=c('group1','n','mean','median'),
          new=c('fyear','n_om','mean_om','median_om'))
> dt_om<-dt_om[,c(2,4:5,7, 16:17)]
> dt_om[1:5,]

    fyear n_om    mean_om  median_om     UL4_om     LL4_om
X11  1993  439 0.08835569 0.08981987 0.09455970 0.08215168
X12  1994  437 0.08958916 0.09132853 0.09586464 0.08331368
X13  1995  466 0.08300514 0.08612373 0.08937619 0.07663409
X14  1996  469 0.08629278 0.08541089 0.09256961 0.08001595
X15  1997  451 0.08866964 0.09021693 0.09544225 0.08189703
```

CI for Competitors ATO

```
> dt_ato<-describeBy(dt$ato, dt$fyear, mat=T)
> dt_ato$UL4_ato<-dt_ato$mean+qnorm(.025, lower.tail = F)*dt_ato$se
> dt_ato$LL4_ato<-dt_ato$mean-qnorm(.025, lower.tail = F)*dt_ato$se
> setnames(dt_ato, old=c('group1','n','mean','median'),
          new=c('fyear','n_ato','mean_ato','median_ato'))
> dt_ato<-dt_ato[,c(2,4:5,7, 16:17)]
```

CI for Competitors ROA

```
> dt_roa<-describeBy(dt$roa, dt$fyear, mat=T)
> dt_roa$UL4_roa <-dt_roa$mean+qnorm(.025, lower.tail = F)*dt_roa$se
> dt_roa$LL4_roa <-dt_roa$mean-qnorm(.025, lower.tail = F)*dt_roa$se
> setnames(dt_roa, old=c('group1','n','mean','median'),
          new=c('fyear','n_roa','mean_roa','median_roa'))
> dt_roa<-dt_roa[,c(2,4:5,7, 16:17)]
```


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CI for Competitors Days Inventory

```
> dt_invdays<-describeBy(dt$invdays, dt$fyear, mat=T)
> dt_invdays$UL4_invdays<-
     dt_invdays$mean+qnorm(.025, lower.tail = F)*dt_invdays$se
> dt_invdays$LL4_invdays<-
     dt_invdays$mean-qnorm(.025, lower.tail = F)*dt_invdays$se
> setnames(dt_invdays, old=c('group1','n','mean','median'),
          new=c('fyear','n_invdays','mean_invdays','median_invdays'))
> dt_invdays<-dt_invdays[,c(2,4:5,7, 16:17)]
```

E.3.3 Merge Competitors Benchmark Data

```
> dtmerge <-merge(dt_om, dt_ato, by="fyear")
> dtmerge <-merge(dtmerge, dt_roa, by="fyear")
> dtmerge <-merge(dtmerge, dt_invdays, by="fyear")
> dtmerge[1:5,]

  fyear n_om    mean_om  median_om     UL4_om     LL4_om n_ato
1  1993  439 0.08835569 0.08981987 0.09455970 0.08215168     0
2  1994  437 0.08958916 0.09132853 0.09586464 0.08331368   431
3  1995  466 0.08300514 0.08612373 0.08937619 0.07663409   452
4  1996  469 0.08629278 0.08541089 0.09256961 0.08001595   476
5  1997  451 0.08866964 0.09021693 0.09544225 0.08189703   483

  mean_ato median_ato  UL4_ato  LL4_ato n_roa  mean_roa
1      NaN         NA      NaN      NaN     0       NaN
2 1.454721   1.403294 1.511029 1.398413   413 0.1313753
3 1.379355   1.347404 1.432409 1.326301   433 0.1140039
4 1.406315   1.348049 1.457737 1.354893   452 0.1210555
5 1.428066   1.369951 1.480486 1.375645   451 0.1213766

  median_roa   UL4_roa   LL4_roa n_invdays mean_invdays
1         NA       NaN       NaN       449     101.0380
2  0.1294093 0.1418088 0.1209418       457     107.6661
3  0.1161979 0.1238140 0.1041938       491     110.2689
4  0.1213559 0.1307351 0.1113760       498     107.0482
5  0.1287368 0.1315436 0.1112095       478     111.4889

  median_invdays UL4_invdays LL4_invdays
1       95.61458    106.0487    96.02737
```


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```
2       99.93280    113.1268   102.20541
3      101.81257    115.6326   104.90513
4       93.89411    112.1321   101.96421
5      100.10573    116.9451   106.03282
```

E.3.4 Merge WHR to Competitors Benchmark Data

```
> dtmerge <-merge(dtmerge, dt_whr, by="fyear")
> dtmerge[1:5,]

  fyear n_om    mean_om  median_om     UL4_om     LL4_om n_ato
1  1993  439 0.08835569 0.08981987 0.09455970 0.08215168     0
2  1994  437 0.08958916 0.09132853 0.09586464 0.08331368   431
3  1995  466 0.08300514 0.08612373 0.08937619 0.07663409   452
4  1996  469 0.08629278 0.08541089 0.09256961 0.08001595   476
5  1997  451 0.08866964 0.09021693 0.09544225 0.08189703   483

  mean_ato median_ato  UL4_ato  LL4_ato n_roa  mean_roa
1      NaN         NA      NaN      NaN     0       NaN
2 1.454721   1.403294 1.511029 1.398413   413 0.1313753
3 1.379355   1.347404 1.432409 1.326301   433 0.1140039
4 1.406315   1.348049 1.457737 1.354893   452 0.1210555
5 1.428066   1.369951 1.480486 1.375645   451 0.1213766

  median_roa   UL4_roa   LL4_roa n_invdays mean_invdays
1         NA       NaN       NaN       449     101.0380
2  0.1294093 0.1418088 0.1209418       457     107.6661
3  0.1161979 0.1238140 0.1041938       491     110.2689
4  0.1213559 0.1307351 0.1113760       498     107.0482
5  0.1287368 0.1315436 0.1112095       478     111.4889

  median_invdays UL4_invdays LL4_invdays gvkey tic         om
1       95.61458    106.0487    96.02737 11465 WHR 0.11243860
2       99.93280    113.1268   102.20541 11465 WHR 0.10575025
3      101.81257    115.6326   104.90513 11465 WHR 0.08625434
4       93.89411    112.1321   101.96421 11465 WHR 0.07949454
5      100.10573    116.9451   106.03282 11465 WHR 0.08239527

       ato        roa  invdays
1       NA         NA 52.16247
```


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```
2 1.276020 0.13493938 53.13010
3 1.156555 0.09975787 62.29640
4 1.100854 0.08751186 59.19228
5 1.058274 0.08719681 67.97994
```

Remove missing values

```
> dtmerge <- na.omit(dtmerge)
> names(dtmerge)
```

```
 [1] "fyear"          "n_om"           "mean_om"
 [4] "median_om"      "UL4_om"         "LL4_om"
 [7] "n_ato"          "mean_ato"       "median_ato"
[10] "UL4_ato"        "LL4_ato"        "n_roa"
[13] "mean_roa"       "median_roa"     "UL4_roa"
[16] "LL4_roa"        "n_invdays"      "mean_invdays"
[19] "median_invdays" "UL4_invdays"    "LL4_invdays"
[22] "gvkey"          "tic"            "om"
[25] "ato"            "roa"            "invdays"
```

E.3.5 Comparative Analysis

Operating Margin: WHR vs Industy Average

```
> plot.om<-ggplot(dtmerge, aes(x = fyear, y = mean_om)) +
     geom_point(size = 4) +
     geom_errorbar(aes(ymax = UL4_om, ymin = LL4_om))+
     geom_point(aes(y = om, colour = tic), size=4)+
     ylab("Operating Margin")
>     plot.om
```

Asset Turnover: WHR vs Industy Average

```
> plot.ato<-ggplot(dtmerge, aes(x = fyear, y = mean_ato)) +
     geom_point(size = 4) +
     geom_errorbar(aes(ymax = UL4_ato, ymin = LL4_ato))+
     geom_point(aes(y = ato, colour = tic), size=4)+
     ylab("Asset Turnover")
>     plot.ato
```


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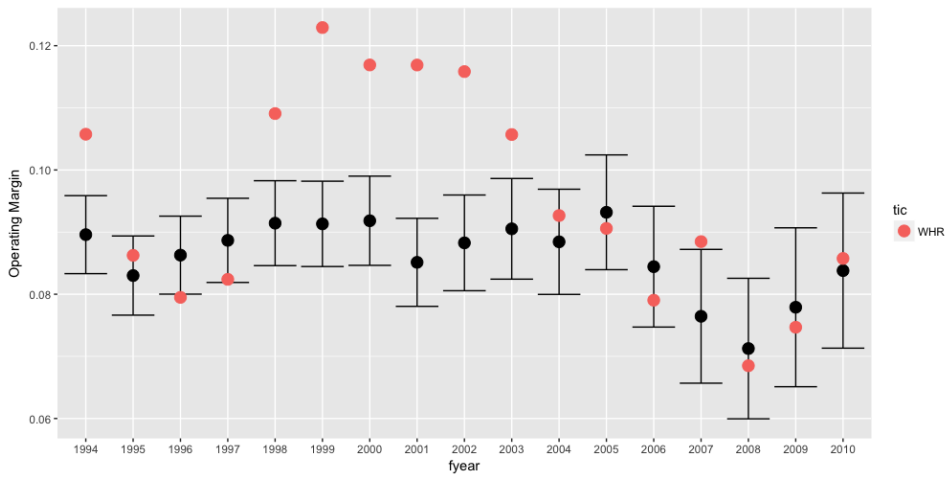

Figure E.1: Operating Margin: WHR vs Industy Average

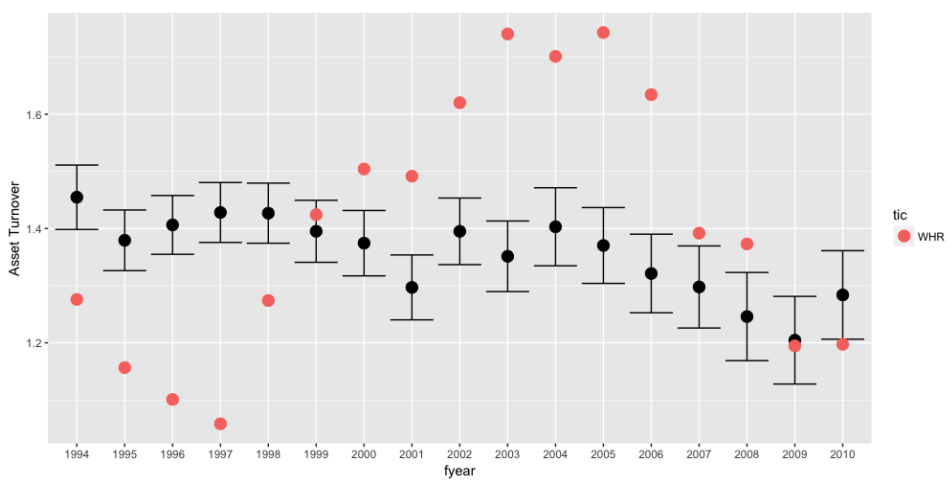

Figure E.2: Asset Turnover: WHR vs Industy Average

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ROA: WHR vs Industy Average

```
> plot.roa<-ggplot(dtmerge, aes(x = fyear, y = mean_roa)) +
     geom_point(size = 4) +
     geom_errorbar(aes(ymax = UL4_roa, ymin = LL4_roa))+
     geom_point(aes(y = roa, colour = tic), size=4)+
     ylab("ROA")
>     plot.roa
\begin{Schunk}
\begin{Sinput}
> grid.arrange(plot.om,plot.ato, plot.roa,ncol=3)
```

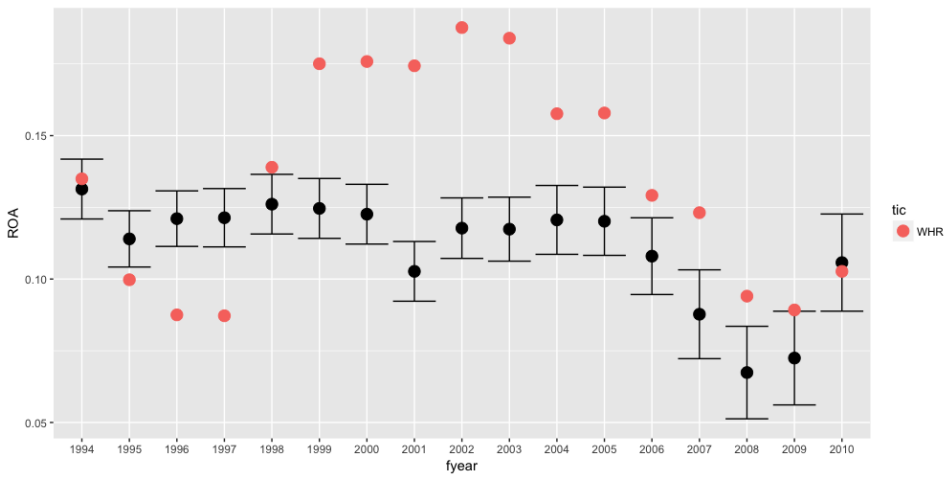

Figure E.3: ROA: WHR vs Industy Average

Days Inventory: WHR vs Industy Average

```
> plot.invdays<-ggplot(dtmerge, aes(x = fyear, y = mean_invdays)) +
     geom_point(size = 4) +
     geom_errorbar(aes(ymax = UL4_invdays, ymin = LL4_invdays))+
     geom_point(aes(y = invdays, colour = tic), size=4)+
     ylab("invdays")
>     plot.invdays
```


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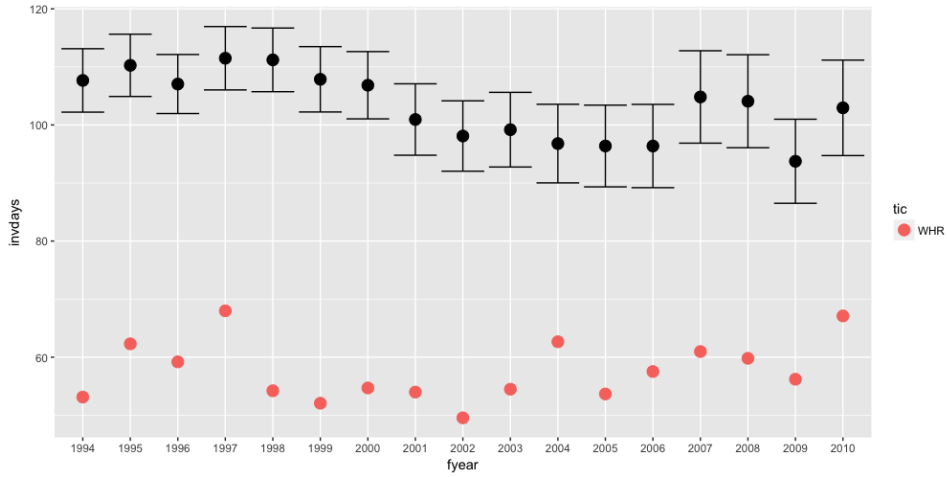

Figure E.4: Days Inventory: WHR vs Industy Average

WHR: Days Inventory

```
> plot.invdays_whr<-ggplot(dtmerge, aes(x = fyear, y = invdays)) +
     geom_point(size = 4)
>     plot.invdays_whr
```


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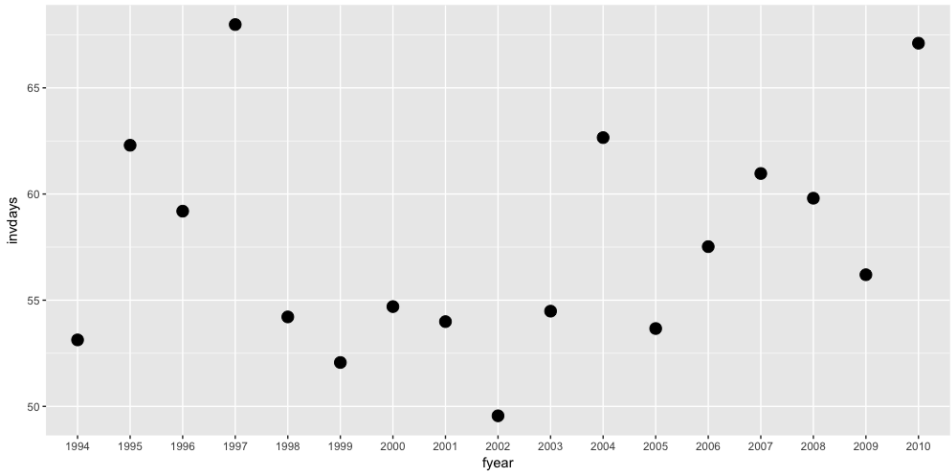

Figure E.5: WHR: Days Inventory

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Part V

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