Design and Process Solutions for Decreasing Vendor Defects

by

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Submitted to the MIT Sloan School of Management and the Engineering Systems Division in Partial Fulfillment of the Requirements for the Degrees of

Master of Business Administration
and
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In conjunction with the Leaders for Global Operations Program at the Massachusetts Institute of Technology

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Abstract

Why do some new initiatives fail while others succeed? This thesis attempts to answer this complex question by investigating the failure of a defect tracking initiative at Amazon and examining how a reintroduction of the process succeeded.

Amazon is a very complex and dynamic organization that has both a corporate headquarters as well as a regional fulfillment centers. In distributed organizations like this, successfully implementing network-wide process improvements can be critical to the success of the business. Consequently, Amazon is constantly attempting to roll-out new improvement efforts. Unfortunately, some of these initiatives fail to reach their full potential.

Common suggestions for the failure of initiatives include lack of management support, poor technology, limited communication, or lack of vision. This thesis argues that while these suggestions are valid and important when designing a process, these alone cannot by themselves show whether the initiative is destined for success or doomed to failure. To better understand the success rate of the initiative, one must do a deep dive into the incentive structure, motivations, and perceptions of all stakeholders involved in a new process.

In 2010, Amazon introduced a defect tracking tool. Adoption grew during the first five months, but declined rapidly during the second half of the year. In 2012, I reintroduced the same defect tracking tool but made a number of minor changes to the process. Over the course of 2012, the project resulted in nearly 300,000 defects and nearly one million dollars in vendor chargebacks. More than 50,000 defects were filed in the month of December alone, compared to less than 4,000 in the month January. Approximately 1000 people used the tool at more than 30 different sites.

This thesis illustrates how system dynamics modeling of the Amazon defect tracking process can be an effective tool for a more complete understanding of adoption or abandonment rates. At a broader level, this thesis discusses methods for designing new processes or modifying existing ones so they are more likely to succeed.

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I would also like to thank Amazon.com for its sponsorship of this project and for its continued support of the Leaders for Global Operations program. Special thanks go to Laura Kaegenbein, Erin McGraw, Maneesh Jyoti, Bill Campbell, Wendy Tse, and Bijal Metha as their time, mentorship, and suggestions on the defect tracking process were critical to the success of the project. I would like also to acknowledge the Leaders for Global Operations Program for its support of this work.

Finally, I would like to thank my parents and brother for their continued support. Their phone calls and encouraging messages brightened my day and helped me get through these past two years.

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1 Introduction

The purpose of this thesis is to identify methods for implementing large-scale improvement initiatives across a network of sites. The research project was done as part of an internship at Amazon.com from February 2012 to August 2012 in conjunction with the Leaders for Global Operations program at the Massachusetts Institute of Technology. This thesis is a result of this internship and the collaboration between Amazon.com and MIT faculty.

1.1 Project Motivation

Jeff Bezos, Amazon.com's founder and CEO built the company to be "Earth's most customer centric company" [1]. As a consequence, Amazon.com strives to provide both a diversity of products and low prices to its customers. This has led to a proliferation in the number of suppliers to Amazon.com and has increased the complexity of the process that brings products from its suppliers into Amazon's fulfillment centers. From time to time, the shipment from suppliers may have mistakes including missing barcodes or expired product. Consequently, the amount of time fixing incoming product that does not meet Amazon specifications has continued to increase while the standard processes (pick, pack, receive, etc.) have seen improvement in rates. By gathering information about the defects from suppliers, Amazon.com would be able to both improve vendor management as well as receive remuneration for these defects in the form of vendor chargebacks.

In 2010, a defect tracking initiative was rolled out across the Amazon fulfillment network in an effort to both better understand and correct this problem. Despite strong adoption initially, within only a few months, usage of the tool plummeted. By early 2012, usage of the defect tracking had almost stopped entirely and vendor chargebacks were all but non-existent.

This thesis examines the reasons as to why the initial roll-out of the defect tracking software failed and then highlights the changes made for the re-introduction of the tool in 2012. Specifically, it identifies potential failure modes of the original roll-out through the use of system dynamics modeling, game theory, and qualitative interviews and shows how these potential failure modes were corrected in the 2012 roll-out.

1.2 Problem Statement

Large-scale vendor management can be extremely complicated but it is important to do it right for financial and business purposes. Supplier management at Amazon was hindered by the lack of defect data. Suppliers are managed by teams based at Amazon.com's headquarters in Seattle, WA. These teams have limited visibility into product defects that suppliers send to Amazon fulfillment centers. This was suboptimal as it failed to take into account the true landed cost of bringing a product into an Amazon fulfillment center and does not account for variations and ability of suppliers to adhere to Amazon shipment requirements. By gathering data about the frequency, type, and cost of defects from suppliers, vendor managers could be better equipped to understand the quality of different suppliers and for certain defects and Amazon would be able to recoup the additional burden of these defects. Furthermore, improving vendor management had the potential to increase the speed and reduce the costs associated with bringing product into a fulfillment center.

Amazon recognized these issues and developed a defect tracking process to capture relevant supplier defect data. However, only a few months after the process was introduced, adoption rates plummeted leading to the eventual abandonment of defect tracking. Although the reasons for defect tracking appear clear and universally supportable, the initiative failed as a result of incentive misalignment, misinformation, pressure from management, delays in the process, conflicting processes hardware problems, and software bugs.

1.3 Project Goals

Despite an impressive track record of growth and process improvements at Amazon, there are still significant opportunities that can have a major impact on Amazon's bottom line. This thesis indicates how one initiative – defect tracking – can be modified in order to improve results. The goal of this project is to help Amazon identify why the initial push to use defect tracking software failed at Amazon and search for solutions for these problems. This will include analysis of the initial process and an examination of the results of the reintroduction of the defects tracking tool. It will also look at the implications this data has on vendor management at Amazon and how these efforts can be applied more generally across industries. These findings are intended to help understand methodologies and practices that will ultimately lead to better initiative introductions at large organizations.

1.4 Thesis Overview

This thesis document is organized as follows:

Chapter 2: Introduction to Amazon.com

This section has a discussion of general background of Amazon.com and their current supply chain. It discusses the inbound process at Amazon and general vendor management policies.

Chapter 3: Literature Review

This section reviews ways for improving the design of processes including system dynamics.

Chapter 4: Problem Analysis

This section analyses the potential failure modes for the defect tracking process using system dynamics modeling and qualitative interviews.

Chapter 5: Solutions

This section describes the ways in which the reintroduction of the defect tracking process attempted to resolve the various failure modes. It also discusses the results of the new initiative.

Chapter 6: Recommendations and Conclusions

This section lays out recommendations for maintaining and expanding the defect tracking initiative as well as how the thesis findings can be applied more broadly to other organizations.

2 Introduction to Amazon.com

Amazon.com has transformed the retail industry by providing unparalleled selection, low prices, and outstanding customer service. With product recommendations from Amazon.com and customer reviews from users, consumers can easily determine the best product for their needs. In addition, new innovations, including Amazon Prime, Amazon Fresh, and Amazon Locker, have improved the customer experience. As a result, Amazon.com has experienced dramatic growth. In 1994, Jeff Bezos founded Amazon and began working in his garage. Today, Amazon has more than 80,000 employees and has a market capitalization of over $120B [2].

Amazon attributes much of this growth to the virtuous cycle or Amazon's flywheel [3][Figure 1]. The internal loop in the diagram can be explained as follows. As selection on Amazon.om increases, it improves the customer experience. This leads to greater online traffic which draws more sellers to Amazon. This in turn leads to additional selection further improving the customer experience. This continual cycle drives growth, leading to economies of scale (i.e. a lower cost structure) which reduces prices further improving the customer experience and driving growth. Amazon has to date done a great job and their revenue results illustrate this flywheel in effect.

Figure 1. Amazon Virtuous Cycle

From a very modest beginning, Amazon's revenue has almost exponentially grown over the last decade reaching over $60B in 2012 [Figure 2]. Despite the US recession in 2008 and 2009, Amazon continues to show year-over-year revenue growth.

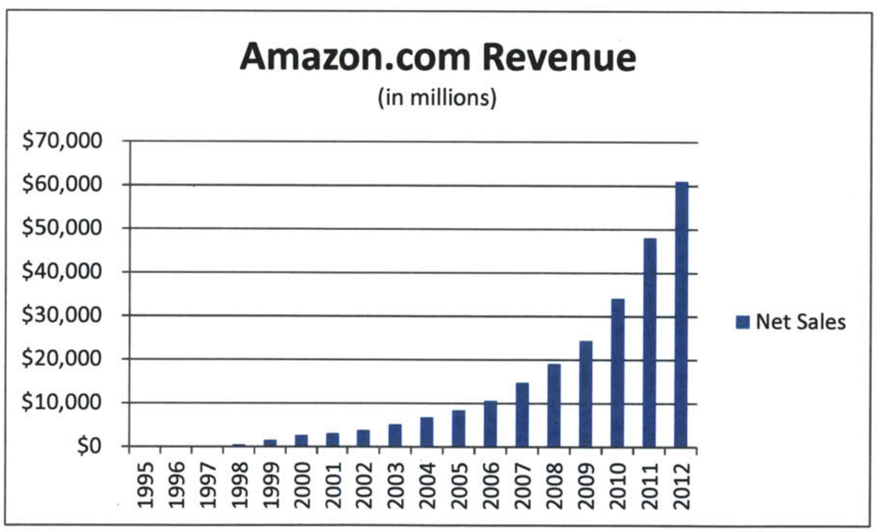


Figure 2. Amazon Revenue Trend [4,5,6]

However, despite the increases in revenue, profits have been more varied. After eight straight years of profits, Amazon's net income was negative in 2012.

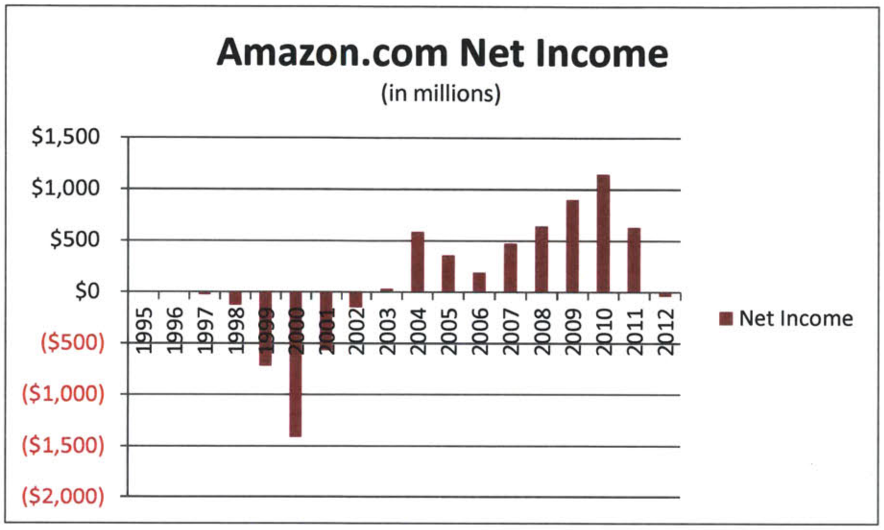


Figure 3. Amazon Net Income Trend [4,5,6]

The purpose of this project is help lower the overall cost structure by eliminating unneeded costs from the inbound process. This will help lower the overall cost structure leading to either net profit increase, a decrease in prices for consumers, or both.

2.1 Amazon.com Supply Chain

Amazon.com's supply chain can be compared to the hub and spoke model. For North American operations, Amazon's headquarters is in Seattle, WA with fulfillment centers located throughout the United States and Canada. Physical operations (receive, pick, pack, and ship) are done at each of the fulfillment centers while the majority of planning (forecasting, transportation, etc.) is done at headquarters.

In the Amazon network, the two most common types of fulfillment centers are sortable and non-sortable. Sortable fulfillment centers handle the majority of smaller items that can be lifted by associates and shipped in standardized boxes. Non-sortable fulfillment centers handle larger and heavier items including odd-shaped items like televisions. The reason for this distinction is primarily to facilitate processing and shipment of product. For example, the resources needed to ship a 60" television may be very different from what is required for a textbook. Although sortable and non-sortable facilities make up the majority of the network, there are a few other fulfillment centers including replenishment centers. At replenishment centers, larger shipments from carriers are broken down into smaller groups and then sent to sortable or non-sortable facilities accordingly.

2.1.1 Supplier Management at Amazon.com

In the early days of Amazon.com, Amazon was heavily reliant on suppliers. As shown through Amazon's flywheel in Figure 1, Amazon needed suppliers to improve selection, thereby improving the customer experience and driving growth. This reliance on suppliers led Amazon to treat its suppliers similar to how it treats its customers. Supplier policies were very favorable which enticed companies to sell on Amazon, benefiting both Amazon and the supplier.

However, as Amazon has grown it has gained significant buyer power as it now can provide both volume and growth for many suppliers. Despite this increase in relative power, Amazon has been slow to make major changes with its suppliers. For example, most suppliers send units in packaging that is more suited for brick-and-mortar stores than for ecommerce although Amazon is working with many suppliers to resolve this.

2.2 Amazon.com FC Operations

The majority of operations within sortable and non-sortable fulfillment centers are broken down into two categories: inbound and outbound. Inbound is commonly referred to as anything having to do with getting the product into a storage place within the building. This includes receive and stow processes. Outbound operations refer to taking a product from a location within the facility and shipping it to the customer. This includes the pick, pack, and ship processes.

Management at a fulfillment center is generally organized into five distinct levels. The general manager has full responsibility for the building. Directly below him or her are several senior operations managers. These senior operations managers focus on specific areas (i.e. inbound or outbound). Senior operations managers oversee operations managers who in turn look after specific shifts. In each shift, there are area managers assigned to specific areas (receive, stow, pick, pack, and ship). Each area manager then oversees a number of associates who directly work to accomplish the specific tasks.

2.2.1 Inbound Operations

Inbound Operations generally consists of two steps: receive and stow. The receive process can be further broken down into three groupings: dock, receive, and problem solve. When a product enters the building from a truck, associates in the dock area bring out the item and prepare the item to be received. This may include opening boxes, removing some packing materials, sorting the items based on size, or moving the product to receive. Receivers then pick up the product, scan the product into the Amazon system, and put the item in containers so it can be stowed. The problem solve station handles everything that does not follow the standard process. Problem solvers handle problems from both the dock stations (i.e. a box shipped to the wrong warehouse) as well as from receivers (missing barcodes, expired product, etc.).

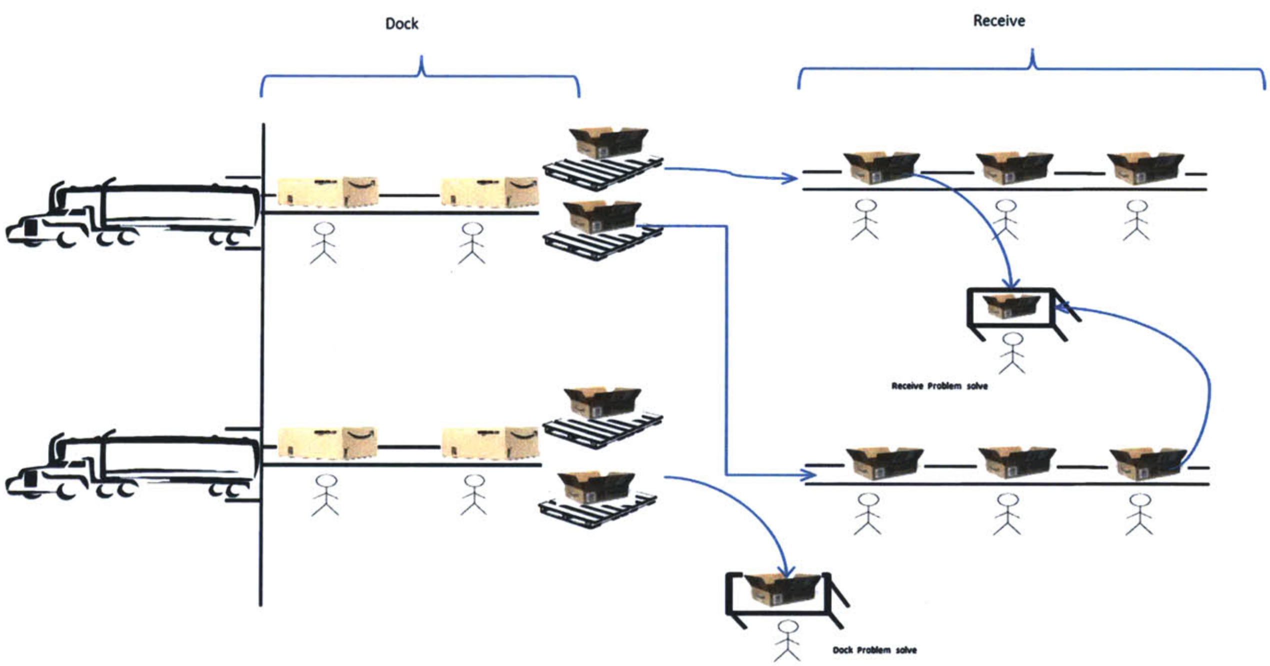


Figure 4. Dock, Receive, and Problem Solve Diagram

The three groups are measured on progress very differently. Receivers have a specific rate target (units per time measure) and are measured against this target and given support, coaching, or other help when this target is not met. Associates on the dock are measured at a less granular level, focusing on the number of trucks that have been unloaded and the number of shipments that have been brought into the building. Problem solvers are not measured on a numeric rate basis. They are given coaching or additional support when the backlog of problem solves begins to grow significantly.

Data collection among the three groups is also very different. Significant data about the rate, volume, and size of product exists for the receive group and dock team. However, very limited information exists for the problem solve group.

Over the past several years, while receivers have been exhibiting better performance on a rate basis, labor expenditures on problem solvers is growing. Labor hours for problem solvers have grown disproportionally with total volume, increasing by 27% per unit from 2010 to early 2012.

2.2.2 History of the Defect Tracking Initiative

In late 2009 and early 2010, a defect tracking software was developed and implemented across the Amazon fulfillment network. This tracking software was intended to bridge many of the gaps discussed above as well as help with vendor management. The web based software was deployed across all Amazon sites globally. More than 100 different defects could be recorded through the system and vendor chargebacks were implemented for two key defects.

The defect tracking tool was used by two types of associates: receivers and problem solvers. Whenever receivers encountered a problem (i.e. a missing barcode, expired product, etc.) he or she was expected to enter or scan in available information about the item. This information could include the purchase order number, shipment number, item barcode, and quantity. The receiver would then input this item into a barcode tagged container which would later be retrieved by the problem solver. When the problem solver scanned this container, the information input by the receivers was retrieved by the system. The problem solver would then use this information combined with the item to identify and correct the defect so that it could be properly received.

The defect tracking software implemented throughout the Amazon fulfillment center network reaching peak usage in June 2010. However, there were a number of unintended consequences to the process including:

- Management pressure
- Delays in supplier behavior changes
- Software glitches

- Hardware problems
- Misaligned incentive structure
- Conflict with other initiatives
- Misinformation

These ultimately led to abandonment of the process at most sites by the end of 2010. The problem analysis and solution section of this thesis will provide a more detailed description of these possible reasons for abandonment of the tool.

3 Literature Review

A study into the literature highlights that there have been numerous articles and frameworks created to help explain why processes fail. This section discusses a few of the more popular frameworks and how they might apply to Amazon's defect tracking process.

3.1 The Four Contradictions

In the article, "Why Operations Programs Fail", Robert Kausaf highlights four areas where plans become unclear and ultimately fail [7].

1. "Does the improvement plan issue a clear and communicated strategy that provides a context for making tradeoffs, determining priorities, and joining departments in a common mission?" In this question, Kausaf shows that while communication or vision statements are often listed as reasons for failure, one must go deeper. It is not enough to provide a broad vision, but rather highlight in what contexts the improvement plan should be followed or adjusted and how priorities should be set. He argues that better planning can lead to better allocation towards strategic priorities leading to the success of improvement initiatives.
2. "Are Management's Actions Consistent with Its New Goals? Has Management Fully Appreciated and Committed Itself to Those Goals?" Lack of management support is often identified as a key issue, but Kausaf points out that management's actions may contradict or appear to contradict management's words. When this occurs, employees are more likely to assume that the actions of management reflect their intentions and as such focus on what they perceive to be important. This can be unfortunate as in many cases, the actions of management

(also known as management style) have been ingrained over many years and cannot be easily changed.

3. "Do Incentives Conflict with the Program Goal?" Incentives are key to human behavior and in many operations examples, employees act rationally based on their incentives. However, these problems can be extremely difficult to correct as both management and workers can be tied to certain performance metrics.
4. "Are Reporting Relationships and Organizational Structure Consistent with Production Imperatives?" In companies with larger groups, reporting relationships can become very important to the success of an improvement project. In a comparison of a product versus a process organization, Kausaf shows that the organization should assess its goals and align its organization accordingly. This may be less relevant at smaller companies, but highlights the need for interconnectivity between groups.

Although these questions spell out major issues that need to be addressed, it can be very difficult to assess these questions prior to implementation of the improvement process. How can process designers know whether management's actions are consistent with the new goal, prior to its introduction? Consequently, this process is useful at examining why processes fail but it may be more challenging to use for process design.

3.2 Reengineering Revolution

In the Reengineering Revolution, Hammer and Stanton argue that business process reengineering failures can be attributed to the following ten factors [8].

1. High-level managerial misunderstanding of business process re-engineering
2. Re-engineering where it cannot fit
3. Spending too much time analyzing existing processes
4. Lack of leadership
5. Timidity in redesign
6. From new process design to implementation
7. Re-engineering slowly
8. Place some aspects of the business off-limits
9. Adoption of conventional implementation style
10. Ignoring the concerns of employees.

While a large list of potential factors, this list appears to miss many key factors including the culture, incentive structure, and organizational structure. Additionally, these factors can be exceedingly difficult to measure and design for. For example, a lack of leadership can mean a number of things and could almost always be attributed to a process improvement failure. Does a leader need to openly articulate support? Should the leader be actively involved in the initiative? Should the leader promote or compensate employees based on their performance with the initiative? While the list is interesting and points to some key areas to focus, the factors are vague and can be too broadly defined.

3.3 McKinsey 7S Framework

While not specific to process improvements, Thomas J. Peters and Robert H. Waterman developed a 7S model that helps to analyze how well an organization is situated to achieve its desired results. The 7-S framework, commonly known as the McKinsey 7-S, identifies three "hard" elements, strategy, structure, and systems, and four "soft" elements, shared values, skills, style, and staff [9].

The hard elements are primarily objects that can be more easily controlled by management. Strategy is managements' plan to build and maintain a competitive advantage. Structure refers to the both the reporting structure of an organization and how units relate to each other. Systems are the processes and routines employed by the organization to complete work. This includes the daily tasks of employees, hiring and promotion, and information systems [9].

The soft elements have more to do with the culture and intangible aspects of the organization. Shared Values are the main beliefs held by employees and the strength of these beliefs. Skills are the capabilities that the employees or the organization as a whole bring. Style refers to the general management style of an organization as well as its overall effectiveness. Finally, staff is the number of people and the different specializations represented by the team [9].

Despite considerable popularity, one of the key gaps to the McKinsey 7-S framework is that it requires one to be able to objectively effectively describe all seven elements. This can be extremely difficult and consequently there may be major gaps in the analysis.

3.4 Brief Review of System Dynamics

To help understand the methodology and implementation section of this thesis, a brief introduction to system dynamics modeling is included here.

3.4.1 Stock and Flow Diagrams

Consider the simple example of modeling the world population. This can be represented using a stock and flow diagram. In this example, there are two flows and one stock. There is an inflow to the population shown as the birth rate and an outflow from the population shown as death rate. The stock in this example is the world population shown in a box in the following figure. Both flows have units of people/time while the world population would have units of people.

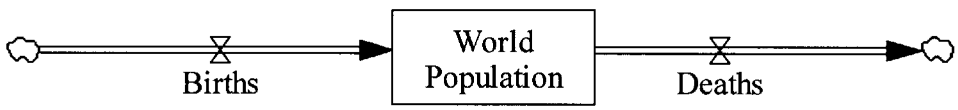


Figure 5. Stock-Flow Diagram

3.4.2 Causal Loops

The stock and flow diagram can be built upon using causal loops. Consider the idea that as the world population grows so does the spread of disease. This is represented by an arrow between world population and spread of disease. As this is a positive effect (an increase in population leads to an increase in the spread of disease), there is a positive sign on the arrow. Similarly, the spread of disease increases the likelihood of death, shown through the arrow from spread of disease to death rate. This loop is considered a balancing loop and is represented by the B with counter-clock wise arrow labeled Disease Loop. It is a balancing loop because as the world population grows, the spread of disease also grows and so does the death rate. With an increasing death rate, the world population declines, bringing it more in balance.

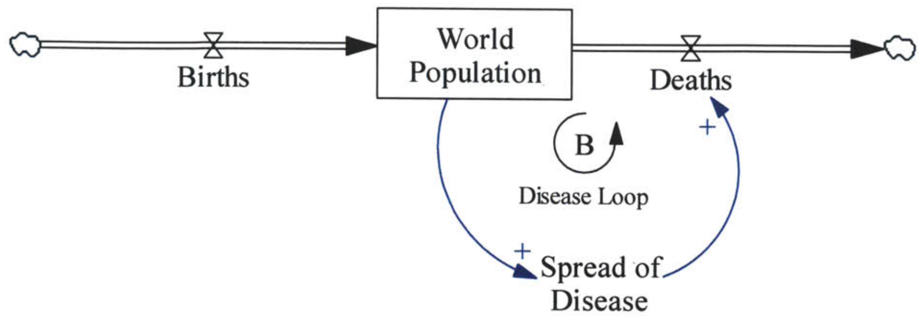


Figure 6. Causal Loop Diagram

3.4.3 Delays

Causal loops can be adjusted for delays. For example, we could argue that as the world population grows, our knowledge about medicine also grows. This is represented as an arrow with a positive sign from world population to Medical Knowledge. As we gain knowledge about medicine, we begin to produce medicine shown as an arrow from medical knowledge to medicine production. On this arrow, there are two parallel lines indicating a delay. This means that there is a time delay between when we gain medical knowledge and when we produce medicine. Eventually, the medicine production leads to a lower death rate as indicated by the arrow with the negative sign. This loop is considered a reinforcing loop because as the world population grows, the medicinal knowledge and medicine production grow leading to a lower death rate furthering the growth of the population. This is represented by the R symbol with counterclockwise arrow labeled as Medicine Loop.

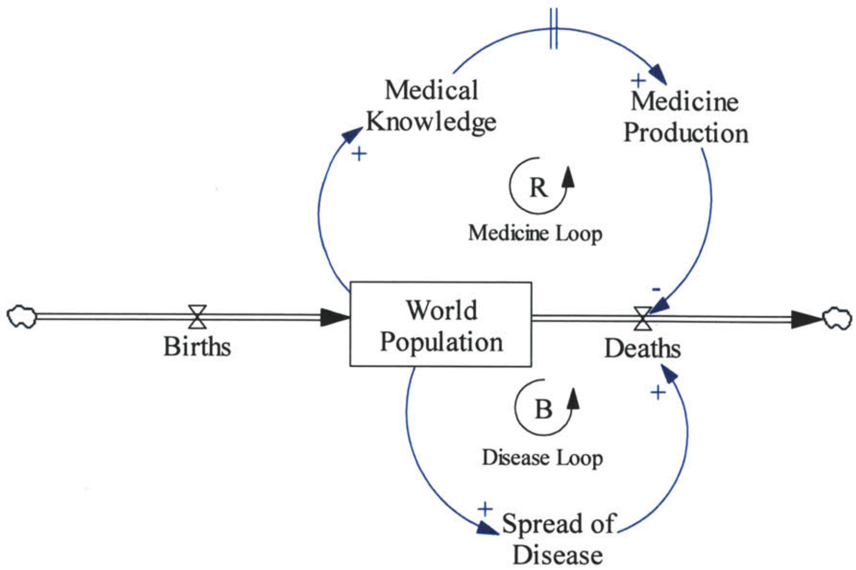


Figure 7. Causal Loop Diagram

4 Problem Analysis

To understand why the initial roll-out of the defect tracking software had failed and to develop a better process for defect tracking, system dynamics modeling was used to identify potential failure modes. These failure modes are derived from the perspective of the associate, or the end-user of the tool. Failure modes caused by management or corporate structure are also addressed, but not explicitly shown using system dynamics modeling.

These models were developed through observation at various Amazon facilities and interviews with associates and management. The interviews were taken over a six month period with individuals at various levels in the organization. The key findings from these interviews and observations have been summarized as failure modes and are addressed in this section.

4.1 Defect Tracking Process Overview

As Amazon grew both its supplier base and volume, a key need was identified in the inbound process. Labor hours for problem solvers, the associates who dealt with defects from suppliers, were increasing disproportionately with volume increases. This suggested that as Amazon had increased scale, there were now either more defects or more time-consuming defects entering the fulfillment centers.

The argument for defect tracking was logical from both the perspective of management and the end-user associates. With defect tracking, Amazon could charge suppliers for specific defects. These charges would eventually lead suppliers to improve their own processes in order to prevent the chargebacks. This in turn, would decrease the amount of incoming defects from suppliers. This had two major benefits to Amazon: Amazon would have to spend less time/workers fixing these defects (leading to a lower cost per unit) and there would be fewer defects that would ultimately reach the customer.

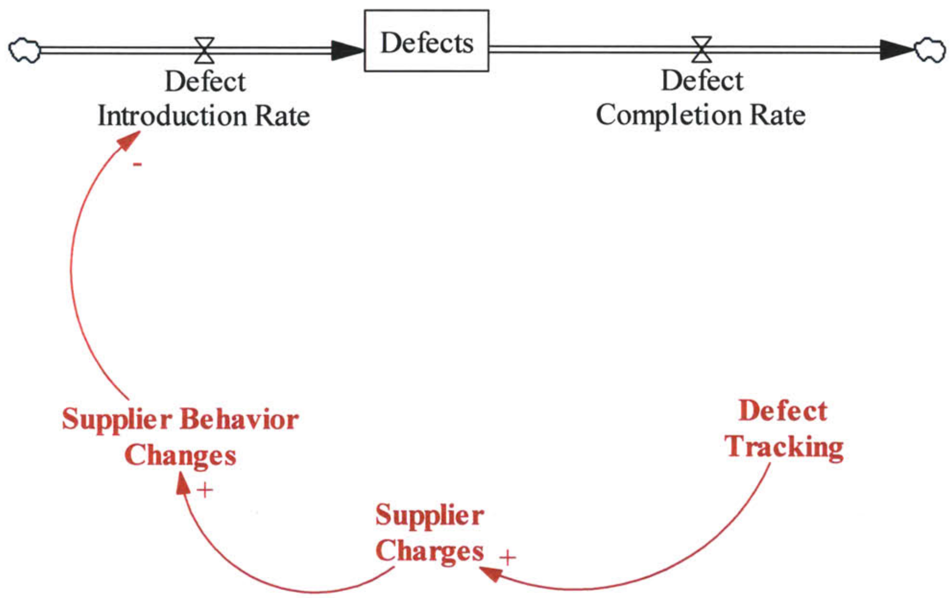


Figure 8. Defect Tracking Process Overview

However, this process had several unintended consequences. First, using the defect tracking tool took additional time. For example, consider a product that came in without a barcode. Before the defect tracking tool was introduced, associates would use any available information (PO, item title, etc.) to identify the product and associate with a specific supplier. Then, the associate would print out the corresponding barcode and affix it to the item before the item was received. With the new defect tracking process, not only did the prior steps needed to be completed, but also, all relevant information (PO, Item #, Shipping Identifier, Quantity, etc.) needed to be inputted. Furthermore, a defect type needed to be specified and a picture of the missing barcode needed to be taken. This led to increases in the amount of time required to fix a defect, decreasing the defect completion rate. A time study performed at one sortable site noted that the time spent by associates to resolve defects increased by approximately 80% when the defect tracking system was implemented. In the model below, as the average time per defect increases, it decreases the defect completion rate. However, the more time spent per defect, the better the adherence to the defect tracking process.

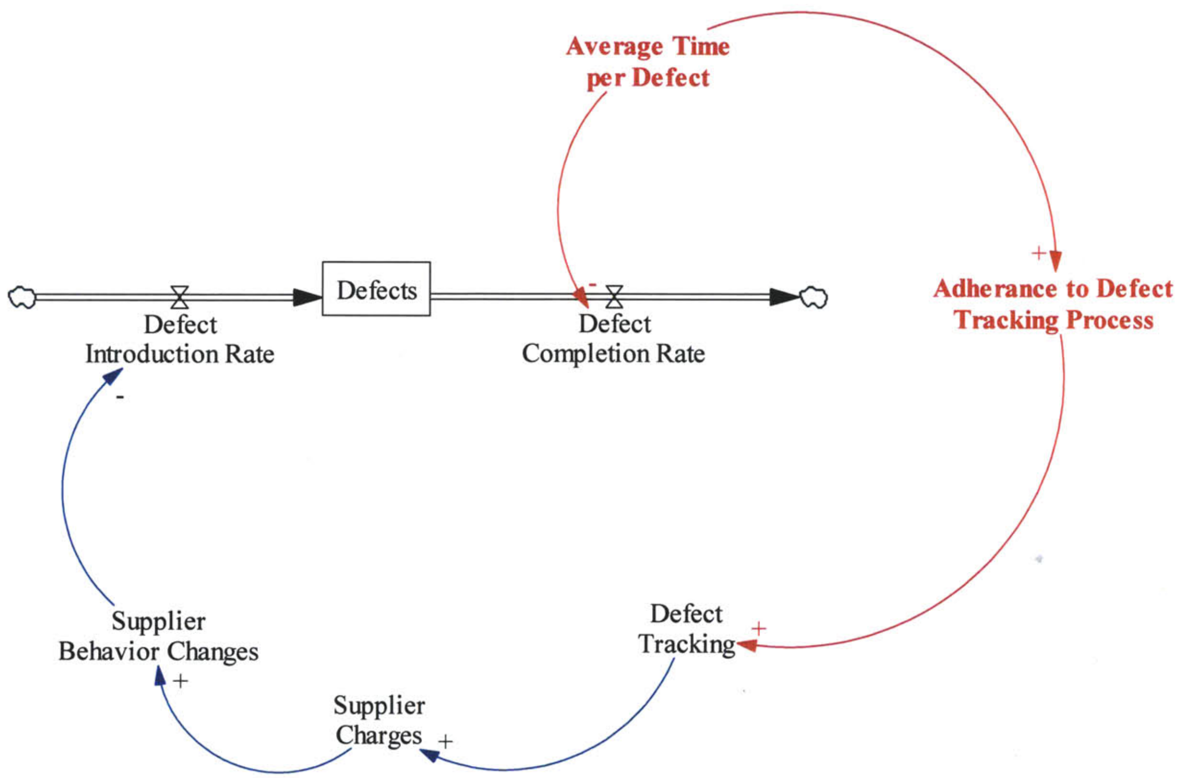


Figure 9. Increase in Time per Task

This increase in average time for the defect tracking process was described as the number one reason as to why the defect tracking process failed. In the re-introduction of the process, very little was done to reduce the time spent by associates. However, the adoption rate and sustainability of the process was drastically improved in the re-introduction of the process. The following sections will expand upon this system dynamic model in order to explain potential failure modes for the process.

4.1.1 Failure Mode #1: Management Pressure

As the defect completion rate decreases, the stock of defects rises slowly. Managers may see this accumulation of defects and as a result put more pressure on problem solvers to finish the work faster. This may lead associates to decrease the time spent per defect, leading to lower adherence of the defect tracking process.

This causes two different types of loops to form. First, when defects rise, management applies schedule pressure so the average time per defect drops. This "corner cutting" leads to a faster rate of resolving defects, reducing the amount in the system creating a balancing loop. Management may notice this immediate decrease in defects and wrongly assume that putting additional pressure on employees works. Without an intervening force to tell associates that they are missing the defect tracking, associates believe that defect tracking is secondary to resolving the defects.

However, management pressure also creates a reinforcing loop known as "process abandonment". As defects rise, mangers increase the amount of pressure on employees. Employees then decrease the amount of time spent on each defect, leading to lower adherence of the defect tracking process. With lower defect tracking, fewer suppliers are charged and poor supplier behaviors are not changed (or worse reinforced), leading to even more defects.

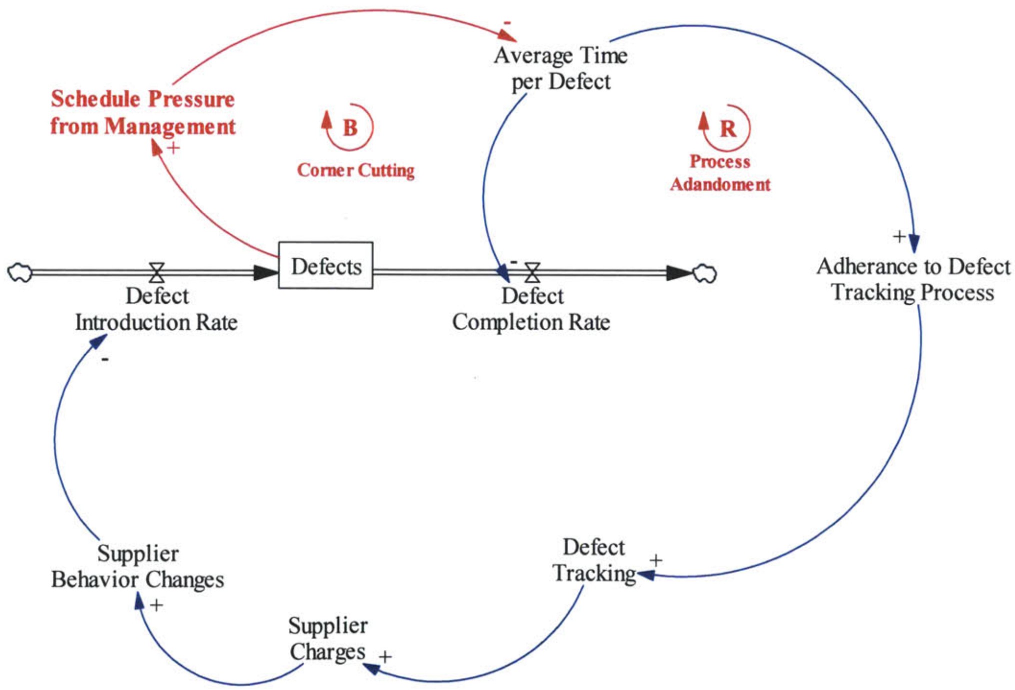


Figure 10. Management Pressure

Although all the managers I spoke with insisted that they never put additional pressure on their problem solvers to finish work faster than was possible, many problem solvers argued the contrary. In some cases, there may have been a misinterpretation of management's actions. Regardless, many problem solvers believed that management wanted associates to resolve the defects as fast as possible, even if that meant temporarily or permanently abandoning the defect tracking process.

4.1.2 Failure Mode #2: Delays in Supplier Behavior Changes

In addition to changes in the defect completion rate, delays between when a defect is tracked to when the suppliers change their behavior can cause management to lose faith in the process. When a defect is tracked, it generally takes several weeks before a supplier is charged for the defect. Moreover, it often takes months and sometimes years before a supplier who is being charged decides to consciously make a change to their process in order to reduce the defects they are sending to Amazon. This is extremely problematic as management often loses faith in the process before a supplier makes a change to its process. From the management perspective, the defect tracking system is taking additional resources but giving nothing in return. Because management and associates have no visibility into supplier charges or planned behavior changes, they may conclude that the process is broken and decide to stop using the new defect tracking tool.

In an ideal world, as the suppliers behavior changes, perception that the defect tracking is working would also increase, leading to better adoption of the defect tracking process. This would lead to more defect tracking, supplier charges, and even more behavior changes from suppliers. This leads to a reinforcing loop that facilitates defect tracking. The delays complicate this though and can cause perception that the defect tracking process is not working, leading to abandonment of the process.

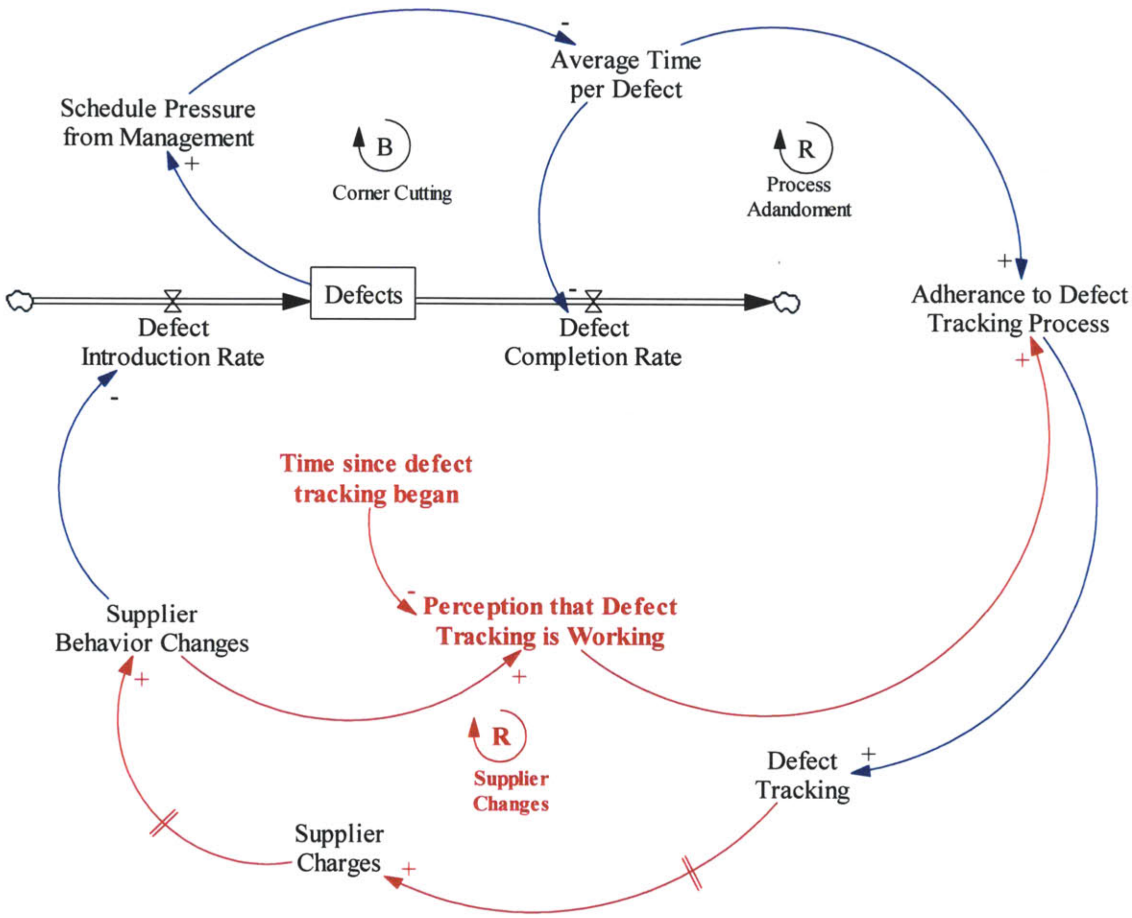


Figure 11. Delays in Behavior Changes

Although not listed as the primary reason for not using the defect tracking process, a few associates and managers claimed that nothing they did seemed to have any impact. The brought up narrative cases of how they logged fifty or more defects from the same supplier in one shipment, only to see the next shipment have the same error. This destroyed confidence in the initiative and led many associates and managers to wonder why they should track the defects if nothing was going to change.

4.1.3 Failure Mode #3: Software Glitches

Glitches in the defect tracking software may lead to two outcomes that threaten failure of the defect tracking process. First, software glitches lead to a perception that the entire defect tracking initiative is not working. This leads to lower adherence to the new process, causing fewer defects to be tracked. As a result, there are no chargebacks and suppliers do not adjust their behavior, leading to a higher defect introduction rate.

Additionally, software defects increase the amount of non-valued added time spent by associates. This lowers his or her ability to correct defects quickly, leading to an increase in the stock of defects. This exacerbates the pressure from management to complete tasks sooner and eventually leads to both less time spent on each defect and lower adherence to the defect tracking process.

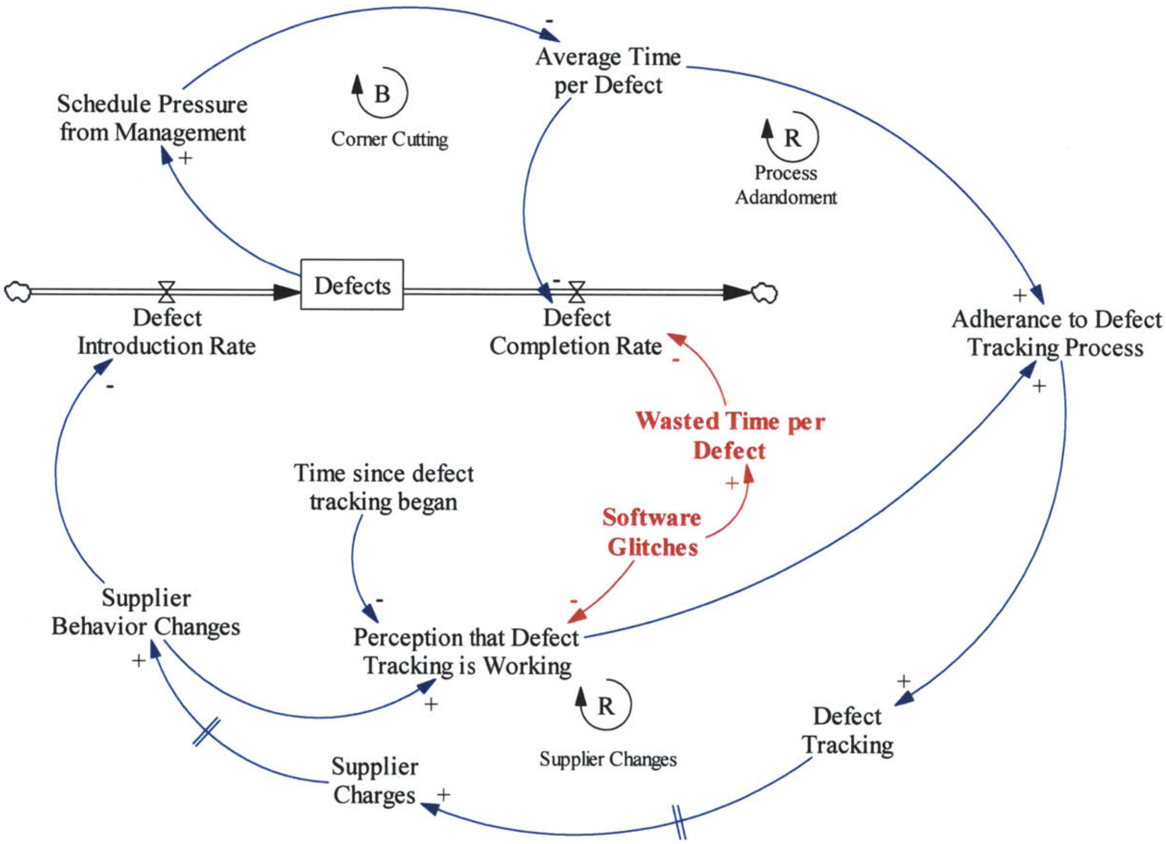


Figure 12. Impact of Software Glitches on Process

Software problems were commonly cited as a major issue in the introduction of the defect tracking process. In 2012, the software failed to correctly capture the defect in the vast majority of cases. Some of these software issues were easily apparent as red error messages came across the screen. However, in other cases, the software glitches were near impossible to identify for associates. While some problem solvers saw no error messages, bugs in the back end of the system cause the defects not to be captured.

4.1.4 Failure Mode #4: Hardware Problems

One of the initial requirements to implementing the defect tracking process was the purchase of a network camera. The camera was required for taking pictures which would be used in the event of a dispute with vendors about the defect. The supplier management team agreed to implement vendor chargebacks, but only with pictures to help prove. The camera required was expensive and came directly out of the budget of fulfillment centers. This alone led many sites to purchase hardware below the optimal amount for budgetary reasons. Consequently, without enough cameras, there was a decrease in the adherence to the tracking process and fewer defects tracked.

Additionally, the specified camera frequently broke down leading to wasted time. This down time limited the defect completion rate and compounded the management pressure issue leading to further decreases in defect tracking.

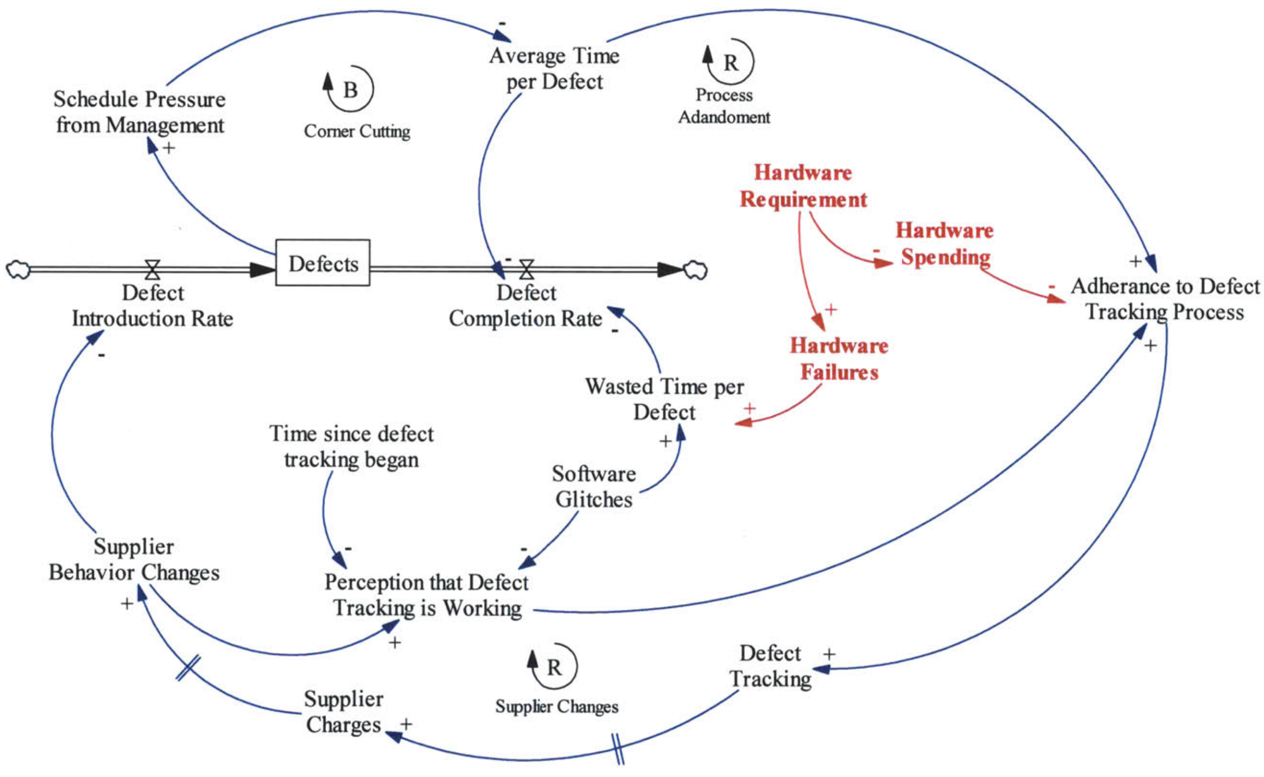


Figure 13. Impact of Hardware Problems

Many users complained about the hardware and did not understand why a different camera option could not be used. In talking with security personnel, some suggested that alternate cameras like webcams and digital cameras were more likely to be stolen. Additionally, these cameras could be easily configured to send pictures or video over the internet and were not preferred. Despite this stance from some security officers, the majority of sites had webcams, digital cameras, or both.

4.1.5 Failure Mode #5: Misaligned Incentive Structures

At Amazon, the vendor chargeback team is located in corporate but is organizationally separate from both the fulfillment centers and the supplier management team. This organization has led to a misalignment of the incentive structure which is described in detail below.

Several of the managers at the fulfillment centers questioned whether his or her site would see any direct compensation for defect tracking. Their argument was that defect tracking takes additional time and resources. These were not planned for in the original budget and therefore will put management at risk of not meeting financial targets. Furthermore, as defect tracking can lead directly to vendor chargebacks, management at some sites argued that a certain percent of those chargebacks should return to the fulfillment center.

This argument, while in some sense valid, does not take into account the complexities and inherent differences between fulfillment centers. Because sites often handled different products, sites were likely to experience a very different makeup of defects. As a result, vendor chargebacks were different for various sites so simply using a percent would lead to major differences in compensation. For example, consider a site that receives a pallet of expired chocolate compared to a site that receives a single book with a missing barcode. In each case, there is only one defect and capturing it would take approximately the same amount of time, however the chargeback to the vendor for the pallet of expired chocolate would be substantially higher than the chargeback for the book missing a barcode. Moreover, since sites do not directly pay for the products entering their facilities, it may not make sense to compensate based on the defects associated with these products.

Despite these concerns, management's argument highlights a misaligned incentive structure. Sites that do not encourage defect tracking will be able to "resolve" defects faster, appearing to be more productive. However, this is a local optimum as if every site stopped defect tracking, the defects from suppliers would not only continue but also likely increase. From a network perspective, if all sites were to track defects, the benefits would far outweigh loses. Reimbursement through vendor chargebacks would more than compensate for the increase in labor and over the long term, suppliers would change their behavior leading to fewer defects. From a site-level perspective though, there is an incentive to skip defect tracking in order to stick to budget and appear more productive.

In addition to the misaligned incentive structure at the fulfillment centers, there was also a misaligned incentive structure for supplier managers. Supplier managers at Amazon were responsible for forging a relationship with vendors to benefit both parties. This involved agreeing on prices, payment terms, and deliveries. Newly introduced vendor chargebacks had the potential to weaken or even dismantle relationships. While Amazon reserved the right to charge for aberrations to the contract, these new charges threatened certain relationships. Vendor chargebacks, although automated, generally increased the workload on the individuals as they needed to both explain and work with suppliers whenever chargebacks were introduced. While supplier defects put an incredible strain on fulfillment centers, since there was very limited data about the most common defects, many supplier managers were shielded from this issue.

Therefore, it was not in the best individual interests of the managers to encourage vendor chargebacks through defect tracking. Again, while defect tracking and vendor chargebacks was expected to be beneficial for Amazon in the long-run, the different shareholders had short-term incentives that directly conflicted with defect tracking.

4.1.6 Failure Mode #6: Conflict with other Initiatives

In addition to the misaligned incentive structure, at approximately the same time as the defect tracking initiative was implemented, an initiative to standardize the work across Amazon was introduced. This initiative attempted to define the specific tasks of each grouping of associate (i.e. receivers, problem solvers, packers, etc.). As part of this initiative, it was determined that the responsibility of the receivers was to receive product and problem solvers were simply intended to solve issues for the receivers.

While simplistic and easy to remember, this interpretation now conflicted with the defect tracking process. As mentioned previously, the defect tracking process involved two types of associates – receivers and problem solvers. In the defect tracking process, when a receiver came across a defect, he or she was supposed to input available information into the system and then put the item in a scanned container. The problem solver would then pick up the container and retrieve all of the information provided by the receiver. The problem solver would then use this information to resolve the defect and complete the tracking.

With the new interpretation of standard work for receivers, inputting defect information for problem solvers was no longer needed. When receivers encountered a defective item, their job was simply to pass on the item to the problem solvers. Inputting information about the product was not considered to be receiving. Consequently, many sites determined that defect tracking and standard work were mutually exclusive initiatives. As the standard work initiative became more pervasive, a number of sites abandoned the defect tracking process.

4.1.7 Failure Mode #7: Misinformation

In addition to the failure modes discussed, interviews suggested that there was one other reason that many sites decided to stop using the defect tracking software – misinformation. While some potential users were unaware of the defect tracking tool's existence, a much larger number knew about it but mentioned that it was not effective for a variety of incorrect reasons.

In particular, there were a variety of opinions about vendor chargebacks. Some interviewees claimed that the defect tracking software never charged suppliers for defects and as such it was a waste of time for anyone to use it. However, most interviewees believed that it did chargeback suppliers but at an almost insignificant amount. A number of people suggested that the labor cost for inputting information in the defect tracking system outweighed the amount returned by vendors. Estimates for the amount of vendor chargebacks generally ranged from 1/10000th to 1/20th of the actual amount. One manger cited the low chargebacks as the primary reason for instructing his employees to stop using the defect tracking tool. Despite discussing the matter with more than a hundred people at various levels in the fulfillment centers, not one was able to correctly describe vendor chargebacks. This difference between reality and perception of vendor chargebacks ultimately contributed to sites not using the defect tracking software.

4.2 Summary of Failure Modes

The seven potential failure modes (management pressure, delays in supplier behavior changes, software glitches, hardware problems, misaligned incentives, conflict with other initiatives, and misinformation) are not intended to represent a comprehensive list of reasons as to why the process ceased to be used. However, this analysis supports the argument that they are the primary reasons for failure. In addition to the discussed factors, there were a number of other factors considered including employee turnover, process ignorance, and software ease of use. A full examination of the organization, defect tracking process, and software were combined with qualitative interviews to determine these potential failure modes. These seven failure modes do provide areas for potential process improvement which is examined in the next section.

5 Solutions

In this section, various methods for attacking the seven failure modes discussed in the previous section will be presented.

5.1 Methodology/Implementation Approach

Over a period of six months, I used my analysis to pilot and deploy a new process across the Amazon North American network. My approach was simply to attack the various failure modes discussed and work to implement process changes that eliminated or weakened the potential failure modes. My responses to failure modes were not implemented in order, but are organized to provide symmetry to the failure modes presented in the prior section. During the pilot phase, the majority of my time was spent in various Amazon fulfillment centers where I was able to implement my changes. I evaluated the effectiveness of these changes by gathering data about how the process was being followed over the next few weeks and made adjustment to the process if necessary.

5.1.1 Attacking Failure Mode #1: Management Pressure

One of the first things evident in the analysis of the process was that a process would fail if area managers were not engaged and committed to the process. This is most evident in the modeling of failure mode #1 – management pressure. I attacked this problem in two ways – education and focused defect tracking. First, one of the reasons management began to put pressure on associates was that their internal expectations about the number of defects was still tied to the old process with no defect tracking. To help remedy this issue, I worked with managers at the pilot sites to ensure that they understood that the defect tracking would result in a slower rate for problem solvers. Using the time study analysis, I suggested that they allot almost double the amount of time for defects that were being tracked.

While this may have solved the part of the issue, the education alone would have led to other problems. Most sites simply did not have the budget for twice the amount of problem solving labor and would have been extremely resistant if I had only mentioned this. However, to counter for the fact that the defect tracking took so long, I asked sites to only track six specific defects. These defects were determined based on two factors: cost to Amazon and frequency. The costs were estimated based on the time it took to resolve the defect (time studies enumerated this) as well as any other associated costs. For example, the cost of expired products comprised the cost of tracking and resolving the defect, the disposal of the defective product, and the cost to reorder and receive the item. Relative frequency was estimated based on observation at various fulfillment centers, data from the prior roll-out of the tracking process, and interviews with warehouse workers.

Since only six defects were being tracked, the overall defect completion rate was less impacted and more importantly, the perception that this change would have on the problem solve hours was severely reduced. Limiting the impact on the defect completion rate combined with the education for management about the impact of defect tracking helped to mitigate schedule pressure from management.

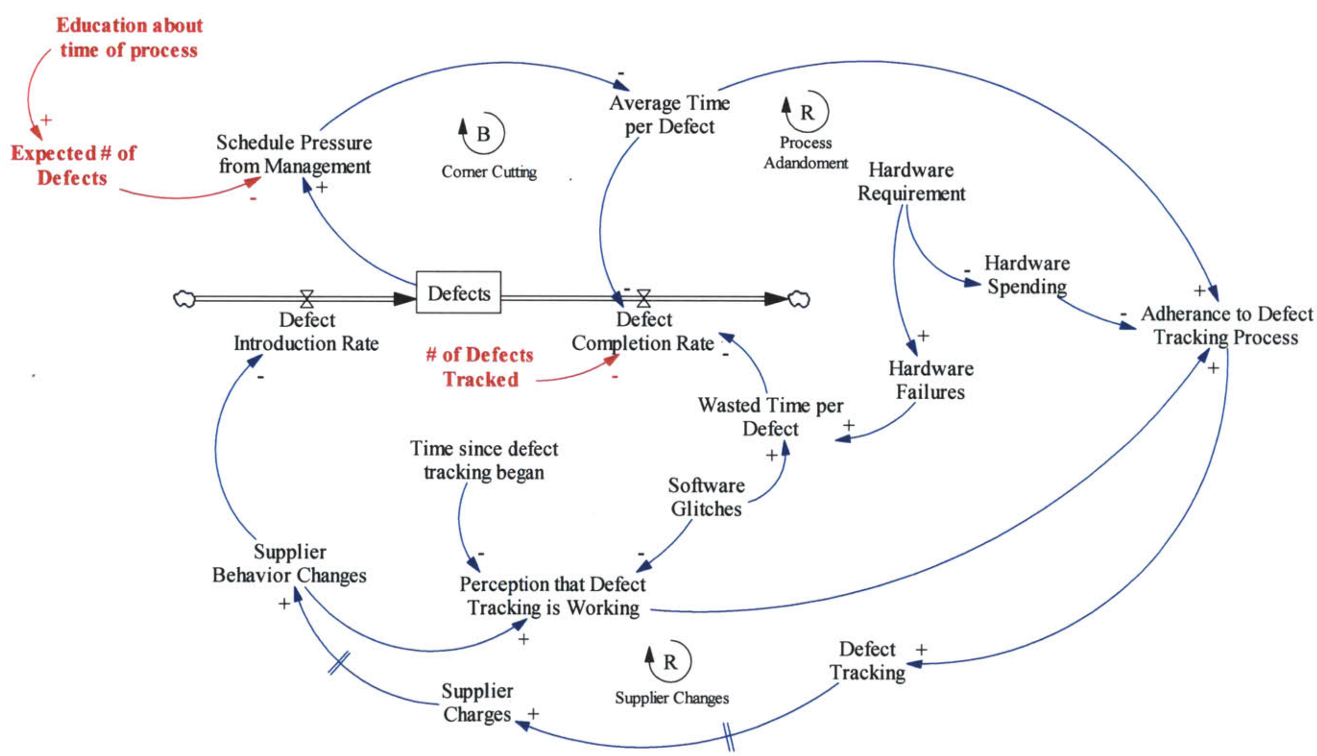


Figure 14. Attacking Management Pressure

5.1.2 Attacking Failure Mode #2: Delays in Supplier Behavior Changes

As illustrated in failure mode #2, actually changing the behavior of suppliers took a considerable amount of time. This was due to the time lags inherent in the system. First, there was a delay between when the supplier shipped the order and when the defect was tracked by Amazon. Furthermore, there are delays between when a defect is tracked and when a supplier is actually charged for that defect and even longer delays between when suppliers were charged and when their behavior changed to minimize the frequency of that defect.

However, because of these time delays, there often was a perception that the defect tracking system was not working. To minimize the impact of this and to engage associates, I developed site chargeback metrics that showed the number of defects tracked and more importantly the amount of vendor chargebacks attributable to a specific site. This along with education about how suppliers were often slow to change in spite of real chargebacks helped to minimize concerns that the defect tracking systems was not working. This led to a reinforcing loop as sites worked to improve their metrics. Despite the delay between defect tracking and supplier charges, the metrics significantly increased the perception of the tool as both associates and managers could see how much they charged vendors.

Moreover, the site specific metrics now allowed management to identify defect trends. It was possible to see which vendors contributed the most defects, which defects occurred most frequently, and which associates were tracking the most defects. This gave management both more ability to effectively manage the defect tracking process and more confidence that the system was working. This led to increased adherence to the defect tracking process throughout sites.

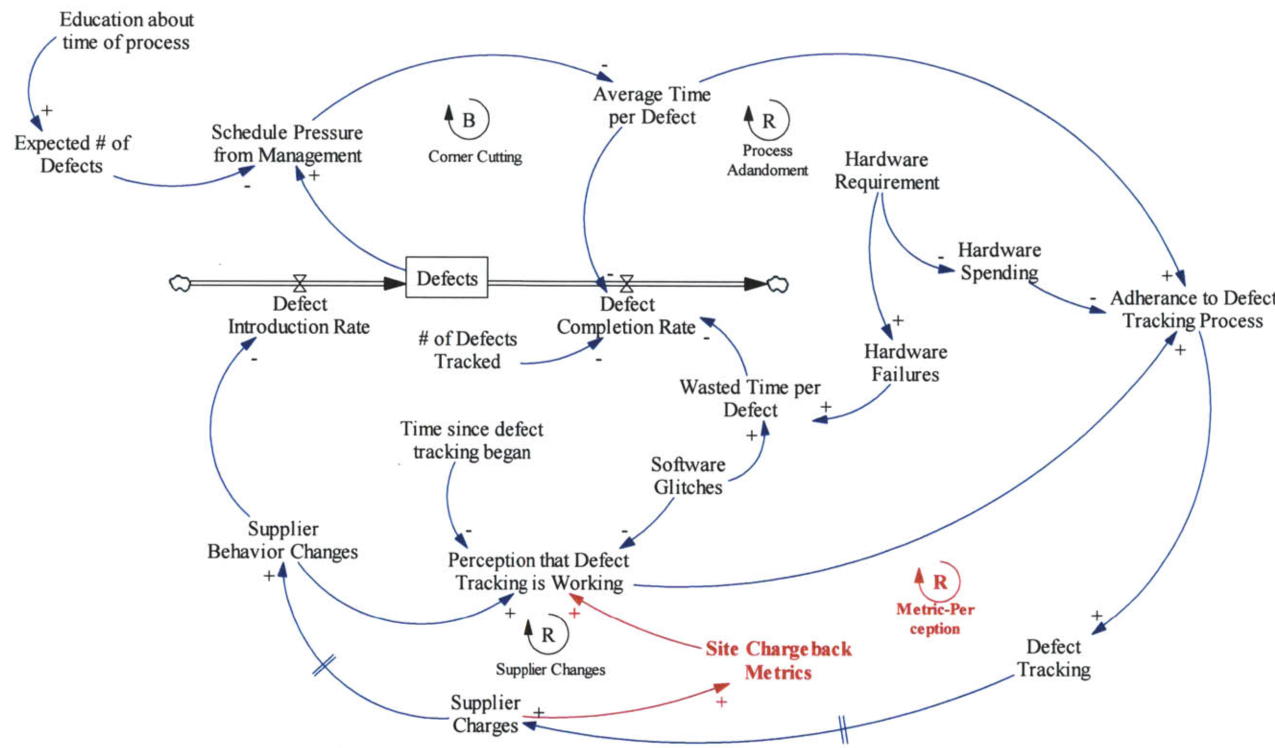


Figure 15. Attacking Delays in Supplier Behavior Changes

An example of the site chargeback metrics is shown in the figure below. Using drop down menus, both managers and associates were able to visually see site-specific trends on usage, picture taking, and chargeback dollars. A detail page included all defects filed with associate logins so managers could provide coaching to not filing defects. This information was available to most people for the first time and provided an incentive and feedback mechanism for continued compliance.

The Excel-based reporting tool also highlighted areas for improvement. For example, defects that were filed without pictures but required a picture for vendor chargebacks were highlighted in red so management could identify the missed opportunities. By providing all North American sites in one location, managers of the different sites were able to compare their progress with similar fulfillment centers.

Figure 16. Site Chargeback Metrics

5.1.3 Attacking Failure Mode #3: Software Glitches

For the majority of 2010 and 2011, the defect tracking software was characterized by a number of software glitches. By early 2012, the defect tracking tool was no longer functional as almost every defect submitted resulted in an error. With a significant push, the software team and I diagnosed, tested, and fixed the most severe software glitches in the system. Despite this, because of the relative age of the system, minor software glitches continued to be uncovered month after month. Even after fixing certain issues, it appeared that these bugs had an instant degradation in the confidence of problem solvers who used the software.

Instead of focusing purely on minimizing these software bugs, I worked with the software team to implement a number of software improvements. These enhancements were able to significantly reduce the amount of wasted time spent on defect tracking. One such example included reducing the amount of information required to submit a defect. Instead of requiring associates to input all information including shipment id, purchase order number, quantity, and amazon standard identification number, the system was modified to eliminate information that could be found elsewhere. For example, if the purchase order was linked to a specific shipment id, users would no longer need to input this information as the shipment id could be identified using the purchase order.

In addition to small time savings for associates, the gradual introduction of software improvements built significant confidence that the defect tracking systems was useful. As software improvements began to take longer, a software wiki page was introduced to highlight which enhancements had already been made to the system and when additional improvements would go into effect. This wiki page, which was available to Amazon associates and managers, emphasized that the defect tracking software was not an initiative that was going to disappear anytime soon and that it was being improved to meet the needs of the fulfillment centers.

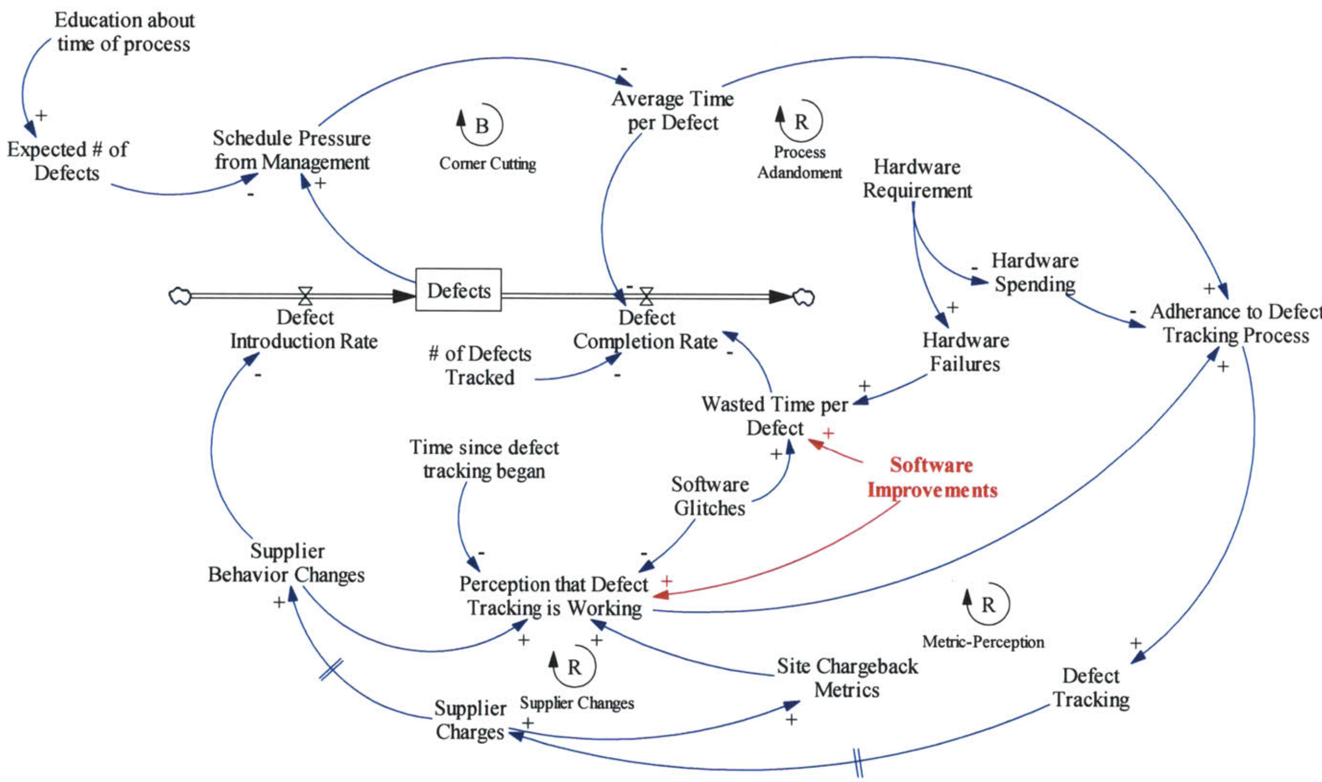


Figure 17. Attacking Software Glitches

5.1.4 Attacking Failure Mode #4: Hardware Problems

One of the more common complaints brought up in the interviews was the network camera required in the initial roll-out. To ensure that suppliers were not incorrectly charged, the designers of the initial system agreed to require a picture for all vendor chargebacks. However, some managers at fulfillment centers had concerns about the security of giving cameras to their associates. The problem solvers involved with the defect tracking wanted a fast way to take the photographs so they could complete the work quickly. To address these concerns, the team decided on a specific network camera. This camera was then integrated into the web interface of the tracking software. This meant that workers could quickly take the required pictures but management did not have to worry as the pictures were not stored locally on the machine and therefore could not be transmitted easily without the software.

While in theory this was a great solution, in practice it had a number of problems. First, the network camera was very expensive leading many sites to limit the number they purchased making it more cumbersome to track defects with pictures when the number of workers exceeded the cameras available. Additionally, the network camera required a cart which was big and bulky. At some sites this was not an issue, but at others where there were significant space limitations, this became an issue as workers had to go back and forth between the camera and their station. The camera was also very delicate and frequently broke down causing both management and associates to be unhappy with the process.

Upon interviewing the different process stakeholders, it became evident that the only requirement was that a picture be taken of the defect. The safety concerns that had once been a major issue appeared to be no longer existent as a majority of the sites I visited had some form of camera (webcam or digital camera) provided to associates for other purposes. However, as each site had its own policy, there were no network standards.

Rather than enforce the old standard or artificially create new hardware standards, sites were given flexibility to determine what cameras fit best. The software was adjusted to ensure that problem solvers could upload images taken, making it very flexible for users. This meant that the additional required spending for hardware was minimal as most sites already had a number of available cameras. While this did increase the time required to upload a picture, it significantly lowered the hardware hurdle for sites leading to increased compliance. For those sites that had found success with the old network camera, the functionality still existed and there was no need to change their process.

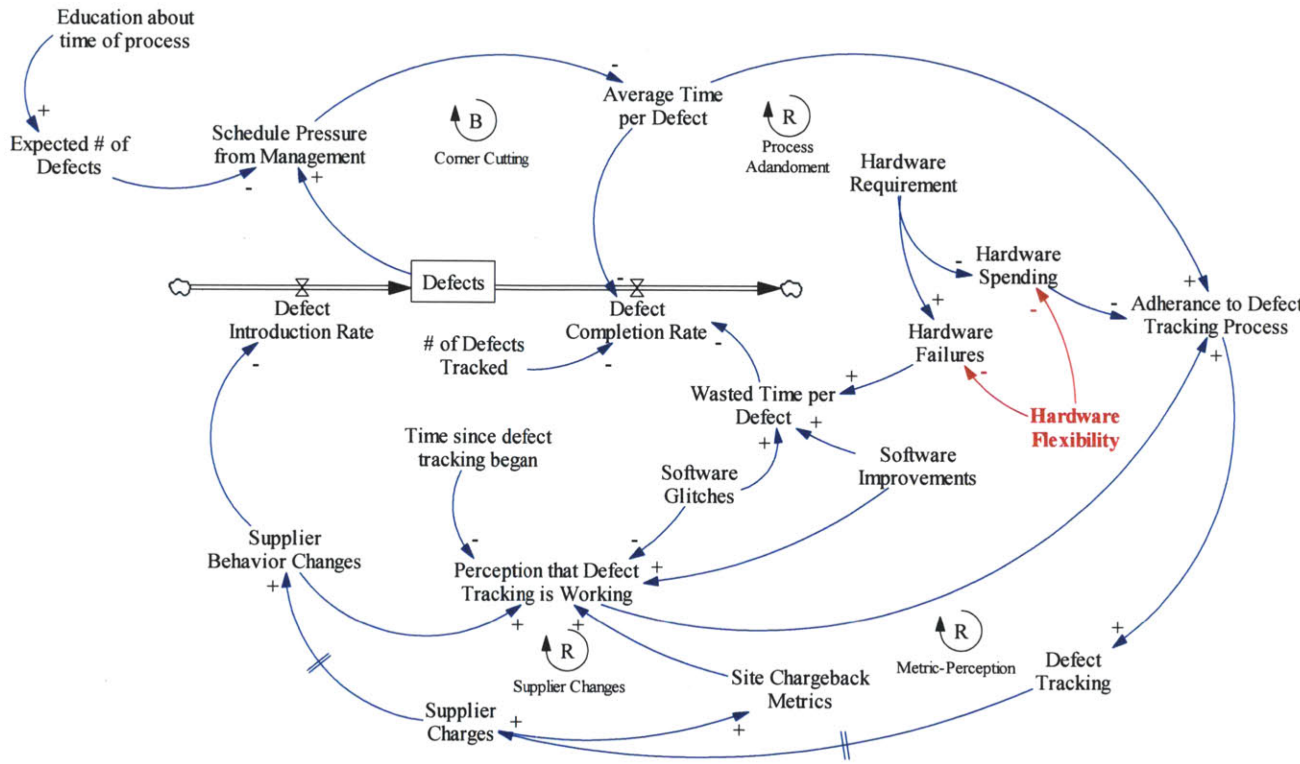


Figure 18. Attacking Hardware Problems

In addition to solving the hardware problem, giving sites flexibility and independence to do what works for them allowed the sites to become more invested in the process. Instead of simply forcing requirement down on the fulfillment centers, both associates and management could now see that they were more in control of the process. This had far reaching implications including the eventual decision by most sites to switch from tracking six defects to tracking all defects. This will be discussed in more detail in the results section.

5.1.5 Attacking Failure Mode #5: Misaligned Incentive Structure

Another issue that surfaced upon investigation of the defect tracking process was the misaligned incentive structure. As defect tracking cost sites labor-hours, managers at the fulfillment center actually had a short-term incentive to not track defects. Consider two sites, A and B who share similar suppliers. If both sites decide to track defects, this will have a positive long-term effect as supplier behavior will eventually change. Since both sites are tracking, neither looks better or worse with respect to management metrics about labor costs. However, consider what happens if site A decides to not track defects while site B continues tracking defects. Site A now gets part of the benefit of defect tracking as site B tracks defects however it looks better to management as it has lower labor-hours with respect to site B. In this scenario, the equilibrium is for both sites to not defect track which over the long-run costs Amazon. The payoffs of the different strategies can be summarized in the following chart.

		Site B	
		Track Defects	Don't Track
Site A	Track Defects	(+,+)	(--, ++)
	Don't Track	(++, --)	(-, -)

Figure 19. Tracking Defects – Initial Roll-out

Interviews with personnel at different sites led me to focus on realigning the incentive structure by educating site management about the benefit defect tracking. As one person I interviewed put it, "I do what my manager cares about." In order to modify the incentive structure, I developed metrics for regional directors – managers who are responsible for overseeing a number of sites. These metrics were the first comparisons of the differences in defect tracking available to this level of management. Regional directors could now see which sites were using the defect tracking process and which were not, as well as which sites were bringing in the most from vendor chargebacks.

This had two distinct implications. First, sites that were using the defect tracking process were now able to use the defects as an explanation for any other missed metrics. For example, previously if a site had come across a number of shipments with considerable defects, it would have had to spend a large amount of labor hours and would have little to show management as an explanation for why they were over budget. Now, by showing how the number of defects had tripled in a single month, managers at fulfillment center were able to explain to their regional directors why they were over budget convincingly.

Next, those regional directors who saw the opportunity for defect reduction and vendor chargebacks were able to manage sites that were not using the tool. By looking at the differences in defects between comparable sites, managers were now able to request that either the number of defects tracked increase or that the amount spent on problem solving decrease if the defects were truly non-existent. This altered the incentive structure to correctly align with the overall incentives of the organization. Using the example of site A and site B from before, the new payoff matrix would be as follows.

		Site B	
		Track Defects	Don't Track
Site A	Track Defects	(++,++)	(-, +)
	Don't Track	(-, +)	(--, --)

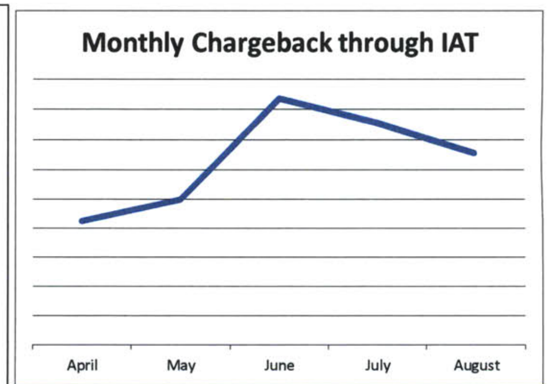
Figure 20. Tracking Defects – Re-introduction

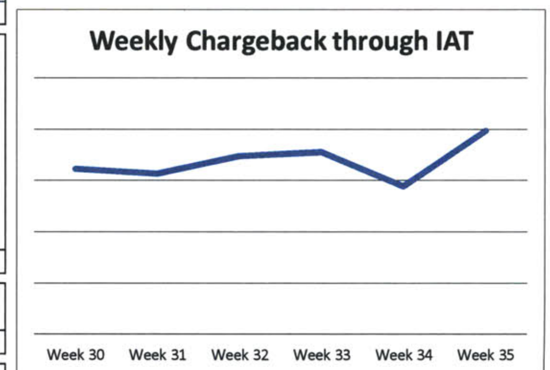
Tracking defects now made sense both in the short-term (to satisfy requirements form management) and in the long-term (to reduce the number of defects from suppliers). Not tracking had a small benefit as the labor hours were reduced, but this was offset as regional directors now would see very few defects and ask for an explanation. Using this altered payoff matrix, the new Nash equilibrium is to track defects for both sites.

Sample regional director metrics can be shown below. The first metric shows all defects captured and highlights week over week changes. Fulfillment centers are grouped according to type (sortable, non-sortable, etc.). Additionally overall monthly and weekly chargeback trends are shown so that management can get a sense of the magnitude this has on the organization.

Total NA Inbound Infractions logged via IAT

		Week 33	Week 34	Week 35	Week 36	WoW Change	May	Jun	Jul	Aug	MoM Change
	Regional Dir.	Total Inf.	Total Inf.	Total Inf.	Total Inf.	Total Inf.	Total Inf.	Total Inf.	Total Inf.	Total Inf.	Total Inf.
Site A	RD 1	348	45	138	359	221	433	1055	847	922	75
Site B	RD 1	234	305	468	346	(122)	781	839	97	490	393
Site C	RD 3	178	205	146	272	126	1015	1027	748	1620	872
Site D	RD 4	272	343	195	222	27	943	963	844	1088	244
Site E	RD 3	435	289	13	97	84	509	376	1309	1383	74
Site F	RD 6	45	350	431	434	3	1950	1000	787	467	(320)
Site G	RD 6	218	374	4	397	393	1822	1937	613	983	370
Site H	RD 4	215	167	76	428	352	964	1309	640	955	315
Site I	RD 1	115	243	474	313	(161)	1921	317	510	1847	1,337
Site J	RD 2	328	18	227	52	(175)	1358	145	616	1275	659
Site K	RD 2	169	36	2	311	309	1935	579	1237	1459	222
Site L	RD 5	374	485	354	189	(165)	1535	476	59	1076	1,017
Site M	RD 4	129	213	438	480	42	1917	1840	768	1432	664
Site N	RD 4	470	286	170	462	292	297	1778	1364	1172	(192)
Site O	RD 4	452	460	260	98	(162)	1564	28	1133	1410	277
Site P	RD 7	96	213	349	331	(18)	614	1139	755	1419	664
Type X		**4078**	**4032**	**3745**	**4791**	**1,046**	**19558**	**14808**	**12327**	**18998**	**6,671**
Site AA	RD 5	191	339	440	173	(267)	147	1651	1348	1938	590
Site BB	RD 3	158	390	487	497	10	559	1638	1536	1267	(269)
Site CC	RD 6	6	292	45	237	192	516	1319	1436	486	(950)
Site DD	RD 6	269	494	391	12	(379)	1829	870	1268	1077	(191)
Site EE	RD 7	437	263	458	290	(168)	1509	151	1786	202	(1,584)
Site FF	RD 7	236	39	135	375	240	980	728	1888	47	(1,841)
Site GG	RD 7	227	406	428	486	58	271	1809	749	192	(557)
Site HH	RD 2	199	416	449	419	(30)	1039	448	980	1655	675
Site II	RD 2	498	221	169	36	(133)	1063	719	1196	1136	(60)
Type Y		**2221**	**2860**	**3002**	**2525**	**(477)**	**7913**	**9333**	**12187**	**8000**	**(4,187)**
Site AB	RD 7	247	202	140	493	353	993	848	1212	1916	704
Site AC	RD 4	150	214	279	449	170	3186	1596	621	764	143
Type Z		**397**	**416**	**419**	**942**	**523**	**4179**	**2444**	**1833**	**2680**	**847**
Site AD	RD 7	457	327	333	201	(132)	542	1745	1764	1616	(148)
Site AE	RD 6	367	185	140	282	142	1922	139	1990	57	(1,933)
Site AF	RD 5	45	313	279	339	60	389	625	843	190	(653)
Type W		**1565**	**1465**	**985**	**1310**	**325**	**5667**	**4403**	**6384**	**3512**	**(2,872)**
Site BC	RD 5	101	363	370	293	(77)	203	692	630	329	(301)
Total		**8362**	**9136**	**8521**	**9861**	**1,340**	**37520**	**31680**	**33361**	**33519**	**158**





Note that there is up to a two week delay between when chargeable infractions are filed and when vendors are charged.

Figure 21. Regional Director Metrics #1[1]

[1] Data represented is general, for illustrative purposes only, and is not actual Amazon.com data

Total NA Chargeable Infractions logged via IAT

		Week 33		Week 34		Week 35		Week 36		WoW Change		May		Jun		Jul		Aug		MoM Change	
	Regional Dir.	Chrg Inf.	% w/pics	Chrg Inf.	% w/pics	Chrg Inf.	% w/pics	Chrg Inf.	% w/pics	Chrg Inf.	% w/pics	Chrg Inf.	% w/pics	Chrg Inf.	% w/pics	Chrg Inf.	% w/pics	Chrg Inf.	% w/pics	Chrg Inf.	% w/pics
Site A	RD 1	34	15%	108	65%	181	8%	129	95%	(52)	88%	43	24%	178	98%	26	2%	159	27%	133	25%
Site B	RD 1	172	58%	190	13%	83	80%	15	67%	(68)	-13%	105	9%	110	17%	15	96%	152	36%	137	-59%
Site C	RD 3	116	82%	198	15%	65	3%	94	66%	29	64%	158	39%	175	35%	35	57%	26	19%	(9)	-38%
Site D	RD 4	146	31%	6	31%	44	46%	132	62%	88	16%	170	23%	47	36%	28	19%	112	46%	84	28%
Site E	RD 3	149	7%	90	84%	43	44%	167	48%	124	5%	116	19%	31	18%	180	85%	147	77%	(33)	-9%
Site F	RD 6	45	56%	193	94%	96	62%	190	15%	94	-47%	59	99%	102	74%	68	68%	20	66%	(48)	-3%
Site G	RD 6	71	46%	126	3%	109	52%	140	23%	31	-30%	97	20%	126	45%	158	37%	81	84%	(77)	47%
Site H	RD 4	124	45%	22	71%	139	12%	56	51%	(83)	39%	130	20%	151	62%	36	46%	45	62%	9	15%
Site I	RD 1	88	12%	38	65%	93	63%	35	90%	(58)	27%	109	18%	37	2%	21	38%	32	45%	11	7%
Site J	RD 2	41	78%	114	14%	28	15%	14	76%	(14)	61%	169	76%	60	26%	102	2%	32	86%	(70)	84%
Site K	RD 2	151	5%	168	40%	186	37%	83	47%	(103)	10%	150	76%	54	50%	78	98%	80	62%	2	-36%
Site L	RD 5	74	16%	99	75%	15	7%	76	87%	61	80%	165	33%	72	1%	150	20%	12	77%	(138)	58%
Site M	RD 4	102	17%	76	4%	18	33%	105	20%	87	-13%	182	91%	45	77%	11	47%	175	21%	164	-27%
Site N	RD 4	184	11%	47	69%	95	85%	130	11%	35	-74%	39	23%	43	78%	61	38%	76	37%	15	-1%
Site O	RD 4	21	20%	118	80%	68	88%	166	75%	98	-13%	133	53%	72	59%	61	93%	94	27%	33	-66%
Site P	RD 7	15	72%	64	31%	87	18%	39	54%	(48)	36%	44	59%	138	69%	190	28%	12	63%	(178)	36%
Type X		**1533**	**31%**	**1657**	**44%**	**1350**	**41%**	**1571**	**49%**	**221**	**9%**	**1869**	**45%**	**1441**	**52%**	**1220**	**47%**	**1255**	**46%**	**35**	**-1%**
Site AA	RD 5	7	89%	148	5%	182	74%	29	9%	(153)	-65%	29	6%	3	30%	40	13%	107	24%	67	11%
Site BB	RD 3	172	67%	148	20%	129	86%	193	2%	64	-84%	131	22%	133	20%	68	73%	153	61%	85	-12%
Site CC	RD 6	117	94%	101	2%	72	42%	40	64%	(32)	22%	140	32%	118	14%	125	46%	152	28%	27	-18%
Site DD	RD 6	51	70%	198	43%	87	31%	20	67%	(67)	36%	56	42%	118	40%	76	77%	59	16%	(17)	-60%
Site EE	RD 7	198	74%	185	33%	152	66%	140	51%	(12)	-16%	144	62%	87	48%	153	69%	60	6%	(93)	-63%
Site FF	RD 7	87	85%	165	11%	144	28%	76	81%	(68)	54%	89	70%	124	5%	41	12%	103	84%	62	72%
Site GG	RD 7	113	46%	74	14%	125	3%	188	61%	63	58%	114	60%	75	49%	19	7%	195	3%	176	-3%
Site HH	RD 2	165	66%	102	1%	12	60%	158	91%	146	31%	174	19%	143	2%	66	12%	185	79%	119	67%
Site II	RD 2	129	47%	1	47%	89	14%	58	24%	(31)	10%	98	67%	165	76%	86	56%	107	86%	21	30%
Type Y		**1039**	**68%**	**1122**	**19%**	**992**	**47%**	**902**	**50%**	**(90)**	**3%**	**975**	**43%**	**966**	**32%**	**674**	**50%**	**1121**	**45%**	**447**	**-5%**
Site AB	RD 7	39	22%	196	93%	80	38%	168	13%	88	-26%	42	13%	18	53%	134	95%	165	78%	31	-17%
Site AC	RD 4	136	2%	38	62%	33	79%	152	39%	119	-40%	102	35%	148	65%	52	71%	68	69%	16	-3%
Type Z		**175**	**7%**	**234**	**88%**	**113**	**50%**	**320**	**25%**	**207**	**-25%**	**144**	**28%**	**166**	**63%**	**186**	**88%**	**233**	**75%**	**47**	**-13%**
Site AD	RD 7	164	31%	58	72%	161	74%	87	19%	(74)	-55%	121	96%	58	12%	114	12%	170	65%	56	53%
Site AE	RD 6	112	25%	54	47%	84	81%	113	98%	29	18%	198	49%	199	11%	122	64%	164	89%	42	25%
Site AF	RD 5	56	12%	164	6%	109	85%	7	6%	(102)	-79%	82	94%	171	35%	66	90%	48	44%	(18)	-46%
Type W		**576**	**50%**	**562**	**40%**	**556**	**67%**	**488**	**68%**	**(68)**	**1%**	**602**	**67%**	**538**	**19%**	**397**	**54%**	**597**	**78%**	**200**	**24%**
Site BC	RD 5	3	80%	146	73%	70	88%	127	63%	57	-25%	50	75%	67	96%	46	25%	20	1%	(26)	-24%
Total		**3326**	**45%**	**3721**	**40%**	**3081**	**49%**	**3408**	**51%**	**327**	**2%**	**3640**	**48%**	**3178**	**42%**	**2523**	**51%**	**3226**	**53%**	**703**	**2%**

Figure 22. Regional Director Metrics #2[2]

[2] Data represented is general, for illustrative purposes only, and is not actual Amazon.com data

The second metric highlight chargeable defects and also indicated missed opportunities. In particular, one metric shows the number of chargeable defects without pictures. These defects are especially troublesome as Amazon could have been charged vendor back for the defect but did not because associates did not include picture documentation.

5.1.6 Attacking Failure Mode #6: Conflict with other Initiative

While many of the other failure modes could have been prevented with a thorough examination of the planned processes, the conflict with the standard work initiative would have been very difficult to predict. Because the initiative had a significant amount of support and the people in charge of this initiative determined that receivers would not be involved in the process, this caused a major obstacle for defect tracking adoption.

Despite the seemingly major setback this had, adjusting the process to account for this is relatively trivial. In the original process design, receivers were in charge of inputting available information and then passing it on to problem solvers through barcode tagged containers. The process can be simply adjusted to eliminate the receivers from the process. As is standard, when a receiver obtains an item with a defect, he or she should send that item to a problem solver. However, now the problem solver is responsible for entering all of the required information to track the defect.

While it may seem suboptimal to have the problem solver enter information that may have been more readily available to the receiver, this may represent an example of where local optimality does not represent a global optimum. For example, if one were to simply focus on the most optimal way to resolve problems, it could be argued that receivers should solve their own problems to prevent the wasted travel of the item between the receiver and problem solver. However, this solution would require all receivers to be trained as problem solvers, significantly increasing the required learning to be efficient. This could cause significant problems during Amazon's peak season and therefore be suboptimal over the long-term. In this case, simply removing the receiver from the process allowed for more ease of implementation as it did not conflict with standard work. Additionally, it made the work of the problem solvers and receivers more clearly defined so that training for the two groups was easier to explain and delineate.

5.1.7 Attacking Failure Mode #7: Misinformation

Interviews with different levels showed major gaps in information about the defect tracking process. Some associates claimed they used the defect tracking software, however upon further investigation, it was shown that they used the tool only to research the item and never submitted the defect. Management severely underestimated the amount of vendor chargebacks and as such assumed that it was not worth the time of their employees to track defects.

To remedy these education and training gaps for both associates and managers, a weekly conference call was setup. In the call, leaders from each of the different fulfillment centers would call in to discuss problems and progress with the defect tracking process. All sites were encouraged to ask questions and provide insights on how to make the tool better. Any major success stories were shared with the entire group so that they could be replicated across the network. Metrics for each site were reviewed and sites that had issues meeting base metrics were given coaching from other fulfillment centers. In addition, basic information about the tool including the amount of vendor chargebacks, the process steps for the tool, and best practices were made available on a wiki and sent out to the group. This was in addition to the already available metrics and the wiki about software improvements.

While the weekly calls did not reach everyone, it reached a number of the key stakeholders which allowed the information to slowly disseminate throughout the ranks. This process of disseminating information was in fact slower than simply finding all people involved in problem solving and giving them the information, however it was much more cost effective and provided a platform for engagement between the different sites. Additionally, it created defect tracking experts at the different sites which could be very useful when the process needed to be setup at new facilities or if a redesign of the process was to be done.

5.1.8 Other Changes

In addition to addressing the specific failure modes, a number of other changes were introduced to help the defect tracking process succeed. During the six months at Amazon, I trained more than a hundred problem solvers about the new defect tracking process. The training focused not only on how to use the tool but also on the reasons behind using the tool. Explaining to associates the need for feedback to vendors and the amount of chargeback appeared more effective than simply showing the mechanics of the tool. A majority of this training was done 1-on-1 at two pilot sites as well as four or five other larger sites. As a consequence, these sites tended to have better adoption, however many other sites in which personal training was not provided performed equally well.

The new process also became part of the latest training manual midway through my time at Amazon. This had a relatively minor impact as most of the training for new problem solvers was done by other problem solvers but this still has the potential to impact future generations as this defect tracking software is now the documented standard.

One major initiative I undertook was getting approval for additional chargebacks. During the six months, I received approval for two additional chargebacks. This gave the defect tracking process further validation as it increased the amount sites were able to charge back to vendors. This increase in vendor chargebacks improved the perception that the process was working leading to better adherence from sites and more defect tracking.

5.2 Discussion of Results

The results from the re-introduction of the defect tracking process demonstrate that relatively small process changes can have a major impact on the success or failure of the initiative. Many of the people I interviewed believed that the old defect tracking software was inoperable and had no place at Amazon. They argued that the software was simply too slow and could never be followed. They recommended developing brand new software and designing a very different process as they felt this was the only way to address their concerns. However, analyzing the process through a system dynamics lens suggested potential failure modes and also possible process changes that would improve the success rate of the process. Unfortunately, as the majority of the process changes were implemented simultaneously, it is difficult to ascertain which specific changes had the largest impact on the success of the reintroduction. More likely, the changes had a cumulative effect that led many to adopt the defect tracking process.

5.2.1 Defect Tracking

One of the simplest measures of success of the reintroduction of the defect tracking process is the number of defects tracked using the system. Despite the various problems identified, there were still in fact some users using the tool in early 2012. From March through May of 2012, the process was piloted at two fulfillment centers. However, there were only small increases in defects tracked for two reasons. First, one of the sites picked was the largest user of the process and had contributed more than half of the total defects in early 2012. The second reason is that during this time, a number of experiments were being tested. Software improvements sometimes affected the uptime of the tool and changes to the process may have contributed to some confusion about which defects to track. The defect tracking software went through several revision cycles during these months to ensure that it met the needs of its users.

In early June, the process was finalized and officially rolled out through the North American fulfillment network, leading so significant gains in the number of defects tracked. From February to July, defects tracked jumped by almost eight times. In August 2012, the regional director metrics were rolled out which may have led to the dramatic increase in the final months of 2012.

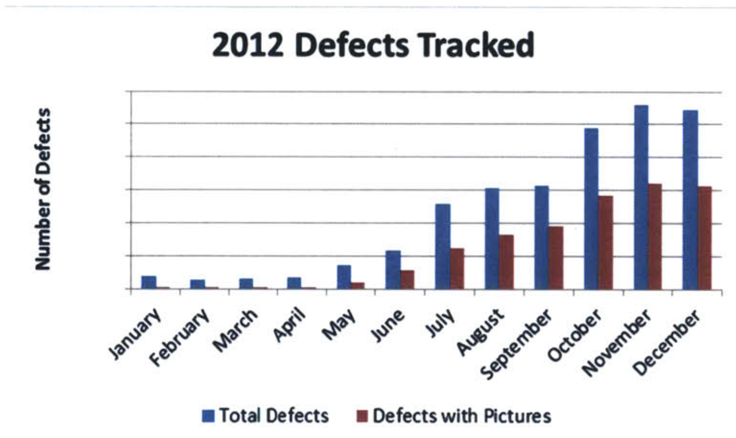


Figure 23. 2012 Defects Tracked

In addition to the changes discussed, it would be prudent to examine Amazon's business cycle and how it relates to this data. As many major retailers, Amazon does the majority of its business in the final quarter of the year (October, November, December). To account for this increase in demand, inbound shipments to fulfillment centers increase substantially starting in September. While this increase in inbound could account for some of the increases in defect tracking, it is unlikely the sole reason for the increase. In the interviews with both associates and management, it was mentioned that during "peak", Amazon's word for the months leading up to December where inbound and outbound volume increase substantially, many non-essential activities including defect tracking, may be ignored in order to ensure shipments make it out in time to the customer. In addition, it is during these "peak" months that many new associates are training which could easily have led to significant gaps in the defect tracking process.

During the initial roll-out, the number of defects tracked plummeted during this timeframe. However, in the reintroduction, the number of defects tracked increased, suggesting that process is more robust and sustainable.

When looking through the data, it was very surprising to find that a number of the defects being tracked were not simply the six defects that problem solvers were asked to track. Interviews with both management and associates indicated that once the process had been established, they found it much easier to simply track everything. Associates did not have to remember which defects to track and which ones to not. Management also felt better about giving a sweeping statement – "Track all Defects." As this appears to be intuitive, one might raise the question as to why we did not track all defects immediately. The data highlights a significant increase from June to July in which the number of all other defect drove dramatically. This can partially be attributed to software changes, but may also be a result of managers changing instructions from tracking six defects to all defects.

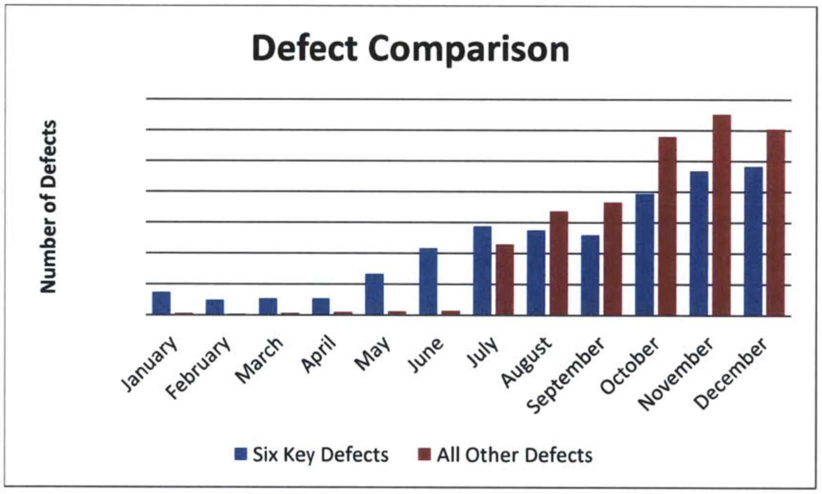


Figure 24. Comparison of six key defects and all other defects

Conversely, using the system dynamics model, it is clear that minimizing the number of defects was essential to encouraging adoption. The reason for this apparent contradiction can likely be attributed to the difference between adoption and adjustment. When the initial request for defect tracking came about, sites were comparing the two options of not tracking defects and tracking defects. By limiting the number of tracked defects to six in my proposal, I was able to show significant vendor chargebacks and limited defect tracking work. If I had instead requested that sites track all defects, the amount of vendor chargebacks would be the same, but there would have been substantially more defect tracking work required. Then, sites would have used short-term cost-benefit analysis to determine if this was truly beneficial for them. This comparison, would have been a much harder sell and likely led to many sites conceding that defect tracking was simply too arduous for them.

However, once sites began using the defect tracking process for the six defects, the comparison shifted to tracking six defects to tracking all defects. In this comparison, they realized that tracking all defects was easier to remember and easier to train associates to do. While there was an added labor cost for tracking these defects, management decided it was worth it as it reduced training and they were able to show better defect tracking metrics. This led to a majority of sites moving from tracking only six defects to tracking all defects without any instigation from myself or others managing the defect tracking process. Adoption was the key issue. It was extremely hard to convince people to go from tracking no defects to tracking six defects, but once sites started tracking, it was relatively trivial to increase from six defects to every defect.

5.2.2 Vendor Chargebacks

Although defects show all defect tracking, another measure of success is the amount of vendor chargebacks. This is the amount that Amazon was able to recoup from vendors for costs associated with specific defects. In order to prevent incorrect vendor chargebacks, Amazon has several restrictions for determining whether a vendor chargeback can occur for a defect.

- Defects must be attributable to a specific vendor. Amazon treats suppliers as "innocent until proven guilty" with respect to the different defects. In cases where it is at all unclear who is at fault for the defect, Amazon will not consider the defect eligible for a vendor chargeback. This is part of the reason that supplier defect tracking was implemented solely in the inbound section. If a mistake were to be found later in the process (i.e. during shipment), it might be uncertain as to whether Amazon or the supplier caused the error.
- Defects must go through an approval process with supplier management. Only a small portion of the supplier defects are currently eligible vendor chargebacks. Whenever there is a proposal for a new chargeback, it must be approved by the supplier management team. As some defects may be too arduous to implement for all suppliers, the supplier manager team must evaluate what defects are acceptable vendor chargebacks and whether the cost for the defect is fair.

- Suppliers may be excluded from chargebacks. Due to certain contract restrictions, some suppliers are not eligible for vendor chargebacks and charges are immediately waived. Additionally, supplier managers are given the power to waive charges for a number of reasons. While waiving charges has potential to be overused, metrics can be developed to discourage supplier managers from overturning charges without reason.
- Defects must include a picture. While this is somewhat of a subset of the first point, all inbound defects are required to have a picture. If a picture is not included with the defect, the defect will be tracked but a supplier will not be notified or charged.

These stringent requirements help to ensure that suppliers are only charged when appropriate. A graph of the vendor chargebacks highlights the immense growth in vendor chargebacks. In 2010, when the original process was rolled out, vendor chargebacks climbed for the first several months peaking in June of 2010. Over the next six months, it dropped by more than 50% and continued to decline in 2011.

Conversely, in the reintroduction, vendor chargebacks increased very quickly in the first three months, but were relatively stable for the next few. Then, chargebacks jumped to a higher level before dramatically increasing in December 2012. The more volatile vendor chargeback numbers are attributable for a number of factors. First, there are more variations in the chargeable defects than there are in the total number of defects. More importantly, there are significant differences in the amount that can be charged for defects. The defect tracking process uses a simple count (not sum of quantity) to determine the number of defects. Vendor chargebacks are determined using a combination of charge per defect and charge per unit. This makes sense intuitively as there is a fixed cost associated with having a defect and a per-unit cost to fix each unit. As a result, while both a pallet of expired chocolate bars and a book missing a barcode would count a single defect, the vendor chargeback for the pallet of expired chocolate would be significantly higher.

Part of the reason for the jumps and then leveling off can be attributed to the accumulation of defects. At certain sites, defects, like expired products, were set aside until associates had time to address them. In some cases that meant that several weeks of defects could be laying around. When the site first began tracking defects, they would see a major increase in vendor chargebacks as they recouped both current defects and defects for the last several weeks leading to an artificially high month. This may help to explain the large chargeback amounts in June and July followed by lower amounts in August and September. The process was rolled out in June however some sites did not start the defect tracking process until July, causing volatility in the chargeback numbers.

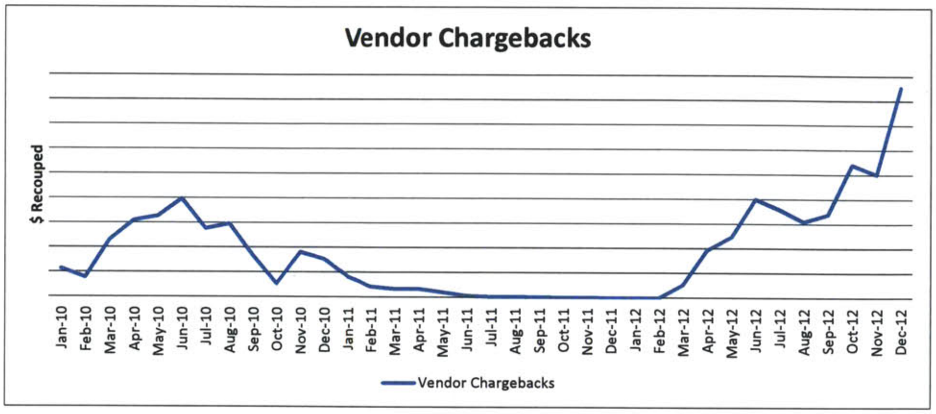


Figure 25. Defect Tracking Vendor Chargebacks 2010-2012

6 Recommendations & Conclusions

The following recommendations are applicable not only to the defect tracking process at Amazon but apply more broadly when a new process is introduced to a complex system.

6.1 Process Flexibility

One of the common fallacies is that if one spends enough time planning and designing a process, they can leave the process alone and let it run. Just as inventory ages and needs to be replaced, so to do processes need to be thrown away or adjusted. A number of outside factors can impact the success or failure of the process and it would be near impossible to account for all of these factors prior to implementation. Therefore, the process needs to have enough flexibility to react to these changing circumstances.

This was evident in the process at Amazon when the receivers to input defect information came into conflict with a standard work initiative. If the process had built-in flexibility, someone may have noticed that receivers were not necessarily needed and could have modified the process so that it worked with the other initiative. In fact, by modifying the process, the defect tracking process owner could have used the standard work initiative as fuel to further drive adoption of his process. As the standard work initiative defined receiver's job as simply "to receive", the job of the problem solver could have been "to track and solve problems". In this way, the processes would not have been in conflict and both initiatives would have supported one another.

6.2 Partial Solutions Work

While intuition suggests that having the best, most comprehensive solution is ideal, in practice partial solutions can often work better. For most new initiatives, getting your feet in the door is critical to the success. Therefore, changes that can make adoption easier should be implemented, sometimes even at the expense of a comprehensive solution. The time at Amazon suggests that increasing the scope of a venture can be much easier to do when the initiative is already ingrained into workers.

At Amazon, an attempt at a comprehensive defect tracking software was initially rolled out. It tracked more than 200 distinct defects and categorized these defects across multiple classifications. This had the unfortunate effect of forcing users to spend a considerable amount of time on defect tracking. Consequently, many users of the defect tracking process abandoned the initiative citing that it just took too long.

By contrast, limiting the number of defects to six represented only a partial solution. If defect tracking is truly the goal, deciding to only track six defects would appear to be impractical. However, in practice, limiting the number of defects initially led to greater adoption as tracking only the six defects did not appear to be a major undertaking. As users and management at the fulfillment centers became more comfortable with process and software tool, they drove for additional defect tracking, leading to a comprehensive solution.

This result may go against intuition as in both cases the sites were tracking all defects, however the progression of moving from six defects to all defects had many benefits. It allowed all users to understand the costs and benefits of using the tool without a significant upfront investment. Similar to other measures, the time spent defect tracking loosely tracked an S-shaped learning curve. When problem solvers first began tracking defects using the software, it took them a significant amount of time. As they used the tool more frequently, they became more comfortable and were able to move faster through the process. If all defects were to be tracked immediately, while users would be able to move to the plateau stage faster, the slow beginning would have a major impact on the organization. Management would see significant productivity declines immediately and might prematurely decide that the defect tracking process is not worth it. The partial six defect tracking solution allowed users to get comfortable with the tool without severely impacting the business.

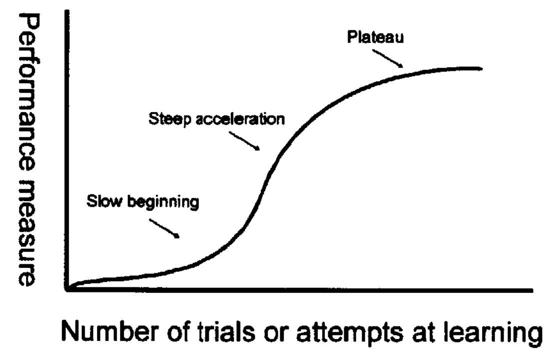


Figure 26. S-shaped Learning Curve [10]

Partial solutions that are easier to implement may have more long-term success than comprehensive solutions that are difficult to put into practice. Moreover, it can be easier to modify procedures to make partial solutions more comprehensive allowing for the same benefit but better adoption rates.

6.3 Incentive Structures

People are driven by incentives and ignoring this concept can lead to the demise of new initiatives. For any new process, it is critical to examine the incentive structure of all impacted parties.

At Amazon, there were several stakeholders impacted by the defect tracking process.

- *Fulfillment Center Associates:* The associates working on the defect tracking process had incentives to finish the work as quickly as possible (able to take a break) and satisfying the needs of their manager (possible promotion, no negative feedback). The initial process did not adequately address these incentives. By not using the process, associates were able to finish their work faster and satisfy management. Management had limited ability to monitor defect tracking, so enforcement for those not defect tracking was very difficult. By contrast, in the revised process, managers can monitor defect tracking providing an incentive for associates to use the process. Furthermore, associates can track the number of defects resolved and amount charged back to vendors leading some associates to care more about increasing their numbers than finishing the work quickly.

- *Fulfillment Center Management:* The management team at the fulfillment teams had a strong incentive to keep labor costs at or below the budgeted amount. With the original process, management saw problem solvers having to spend almost double the amount of time to resolve defects, leading them to worry considerably about the impact of the process on their budget. In the new process, management still worried about their budget, although less so because only six defects were tracked. However, by giving the regional directors metrics about which sites were defect tracking, a new incentive to track defects was introduced, countering the budgetary incentive.
- *Supplier Management Team:* The team in charge of suppliers was primarily interested in making their relationship with suppliers as stress-free as possible. All vendor chargebacks have the potential to threaten this relationship, so limiting the number and amount of the vendor chargebacks is key for this group. While no specific actions were taken, it is important to take note of this as this can be a major factor in the future as the vendor chargebacks expand.
- *Vendor Chargeback Team:* Unlike the supplier management team, this group was measured on the amount of vendor chargebacks recouped by this team. As such, this group may be a powerful ally when introducing new vendor chargebacks or when trying to get support for the initiative more broadly.

By examining the key stakeholders and ascertaining their incentives, one can design processes around potential pitfalls and work to satisfy the needs to each group.

6.4 Supplier Evaluations

In a fast-growing and large organization like Amazon, it can be very difficult to look at all aspects of a supplier. However, in these large organizations it is extremely important to evaluate suppliers holistically. Based on the "flywheel", part of Amazon's competitive advantage is its economies of scale. If the cost of suppliers is primarily evaluated on purchase price, this has the potential for major oversight. Amazon may be losing money on suppliers in which send in defects or cost the organization in other ways.

I recommend evaluating suppliers holistically, both before and after a contract is signed. With defect tracking and vendor chargebacks, suppliers can get a better sense of any pain the supplier is causing at fulfillment centers. While this need not be the primary reason for accepting or rejecting a supplier, it can allow the vendor management team to make better decisions. By considering all factors including transport cost, lead time, quantity of defects, and defect costs among others, Amazon can make more informed decisions.

6.5 Supplier Reactions

One of the more interesting facets of implementing the defect tracking process was the supplier's reactions to the vendor chargebacks. When thinking about vendor chargebacks, one might guess that as chargebacks slowly accumulate, vendors begin to notice those changes and change their behavior to minimize chargebacks. In practice though, there appeared to be two critical times in which suppliers were most likely to change their behavior at Amazon – when chargebacks were introduced and when a "large" chargeback occurred.

When suppliers were first notified that a new charge was going into effect, a number of suppliers were quick to respond to the supplier management team to tell them that they needed more time or the charge was too burdensome. If suppliers recognized that these charges would be substantial, they tended to take one of two options: either changing their process or fighting or extension or removal of the charge. Most that I encountered argued that the charge should be waived as it was impractical or too costly for the supplier to undertake.

The other time when suppliers reacted to vendor chargebacks was when a substantial vendor chargeback. Substantial is dependent on the supplier, but it generally occurred when an entire shipment of product had a defect of some kind. When suppliers noticed major chargebacks, they generally asked the management team for leniency and then discussed plans for potential future charges. In this case and when new charges were introduced, changing the processes at the supplier was generally the last option.

This suggests that having many small charges may do very little to actually change the behavior. If suppliers do not think vendor chargebacks will considerably impact them, they likely will not make any changes to their behavior. As a result, it may be more effective for supplier managers to collect all the data about vendor chargebacks over the course of a specific time period and show them to the supplier. With this, the supplier would be able to realize how much the defects are costing and whether it made sense for them to actually change their behavior. Behavior changes generally tend to take a considerable amount of time without a specific impetus. As Amazon garners more information about the defects, it should target suppliers causing the most issues and work make improvements.

6.6 Further Study

With a functioning defect tracking process, the data available can be used in a variety of analyses. For example, data segmentation about specific data types can lead to key insights. A study done into the expired product defect found that approximately 44% of those defects were attributable to ten vendors. This data is extremely powerful as it now provides a significant amount of information to supplier managers who previously were unable to understand which vendors caused problems. This gives these managers insight into which vendors they should work with. It also provides the supplier managers with strong bargaining information when negotiations for new contracts between the parties are underway.

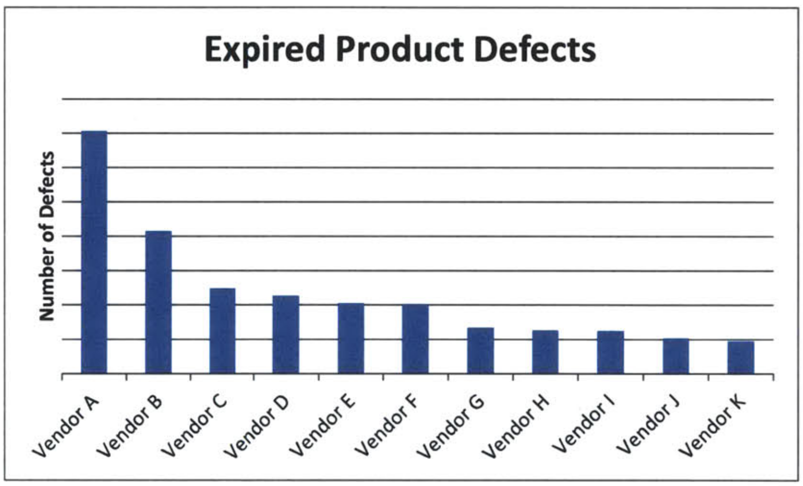


Figure 27. Defect Tracking Vendor Chargebacks 2010-2012

The research can go further than simply identifying problematic vendors. For specific product lines, trends showing the number of defects by week can give insight into larger issues. For example, as this shows that in weeks 24-26, there were more than twice as many defects as normal from grocery vendors. Diving into the data further can explain whether this was the cause of one supplier, increased shipments, or more effective defect tracking.

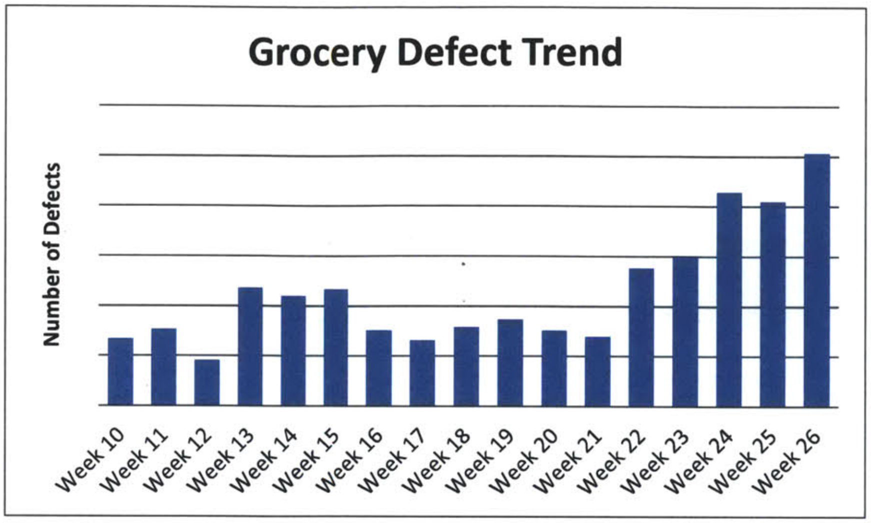


Figure 28. Week over Week Defect Trend

Similarly, management teams at Amazon can better understand which product lines have the most defects. This can be used for labor planning at different sites and strategizing which markets to expand to as well as for where to focus improvement measures.

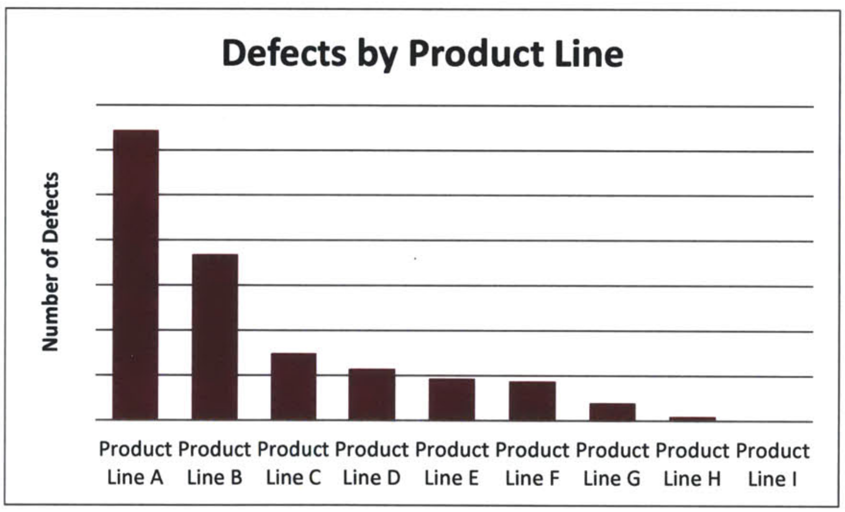


Figure 29. Week over Week Defect Trend

As illustrated, defect tracking data can be extremely valuable to organizations. In a fast-changing environment where suppliers are constantly being added and more volume is being shipped through fulfillment centers, defect tracking provides key insights into areas for improvements.

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