Digitizing Work: Measuring Changes in Information Worker Time Use and Performance With a Quasi-Experiment

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Abstract

We study the causal effects of digitizing work on information workers' time-use and performance at a large insurance firm. We make causal inferences and obtain unbiased estimates by exploiting a quasi-experiment: the phased introduction of Electronic Document Management (EDM) across multiple offices at different dates. We apply a difference-in-differences methodology to econometrically measure changes in a suite of performance metrics. We further triangulate on the effects of digitizing work via three complementary research techniques: extensive onsite interviews before, during and after implementation; detailed time use diaries and observation; and a series of surveys. In addition to large changes in time-use and performance, we find that digitization leads to a decline in the substitutable routine labor input and an increase in complementary non-routine cognitive labor input. We uncover a new micro-level mechanism, "IT-enabled slack", that explains how exactly IT can lead to payoff in terms of information worker productivity.

Keywords: EDM, electronic document management, time use studies, differences-in-differences, productivity, IT payoff

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1 Introduction

Causal effects in fields such as medicine are often estimated using controlled experiments. This is less common in the social sciences because it is often difficult or extremely expensive to control the setting (often organizations) and treatment (often major technology investments and business process changes). In addition to obscuring causality, it is also difficult to estimate an unbiased return to the random adoption of new technologies (or the "average treatment effect") without experimental data (Bartel et al 2004, p. 221). The ideal to strive for would be a randomized controlled experiment in which the treatment is given to individuals or entities selected at random from a population. True randomized controlled experiment however can be difficult to achieve in reality. In this paper, we are able to report on results from a large "quasi-experiment", in which the time of application of the technology and process intervention (in our case electronic document management technology or EDM) to various entities (in our case the offices) is "as if" it was randomly determined i.e. in which randomness is introduced by variations in specific office circumstances such as timing of the implementation of the technology that makes it appear as if the technological treatment was randomly assigned to the offices. The quasi-experiment allows us to get very close to what would be ideal, a randomized controlled experiment, in which the causal effect could be measured by randomly selecting a sample of individuals from a population and then randomly giving the treatment to some of the individuals in the sample.

In the context of a quasi-experiment, we use a four-pronged research study to holistically assess the causal impact of an enterprise IT (EDM) on the workers compensation division of a large insurance firm. Through pre- and post-EDM interviews, time use studies, surveys and

importantly analysis of office-level objective performance and cost data, we qualitatively and quantitatively document the causal impact of EDM. The interviews allow us to understand the behavioral impact of EDM on the employees. The time use studies help us to assess the impact of EDM on the allocation of time by employees to various activities. The surveys help us to assess quantitatively and qualitatively the perceived impact of EDM on various dimensions or measures such as individual case load, new cases, closure rates, amount of paper, communication patterns and time spent doing various activities. Finally, econometric analyses on the objective performance and cost data at the office level allow us to isolate the causal impact of EDM on various bottom line metrics. We combine the results of the econometric analyses with the results from interviews, time-use studies and surveys to understand the true impact of EDM. Our research study is an example of an "insider econometrics" study (Bartel et al, 2004) in which we focus on the operations of a single firm. Insider insights obtained through direct contact with the managers and information workers are key in this type of study, as they reduce concern about endogeneity bias and omitted-variable bias in the results (Bartel et al, 2004). Interviews and direct observations can help the researchers figure out what are the "right data" that need to be collected and also whether other confounding factors that could explain the observed results exist. Further, insider econometrics studies are useful in that they allow the researchers to gather primary data to estimate productivity/performance models in which the independent variables of interest can be expected to have direct effects that can be interpreted meaningfully (Bartel et al 2004, p. 221).

EDM technology is used to manage documents and is often categorized as an information management tool. EDM has been defined as the "application of technology to save paper, speed

up communications, and increase the productivity of business processes" (Sprague 1995, p.29). EDM implementation is literally one of the most visible manifestations of the ongoing move from analog to digital organizations, as paper document and manual routing are replaced by digital documents that are managed electronically. Its salience derives from two facts: valuable information in organizations is stored in the form of documents such as reports, forms, memos, letters etc. and business processes are often driven by document flows (Sprague 1995). Despite its salience, EDM has not received much attention from IS researchers. To the best of our knowledge, few systematic empirical studies exist that assess the business value of EDM. In their review of published and unpublished cases on electronic records management systems (ERMS), Johnston and Bowen (2005) point out that benefits of such systems have rarely been measured and documented carefully (page 139) and most case studies do not report both the full costs and the detailed quantitative benefits (page 137). Many of the case studies are non-academic, where details are lacking, and where it is not clear whether rigorous standards of academic research were used to measure the benefits/costs of electronic document and records management systems (EDRMS). Some of the case studies mentioned in the review include the following: Orange County, California, reporting savings of over $1M per annum from their EDRMS, with additional savings of office space of over 800 square meters (Winton, 2003); Transport Canada reporting an ROI of 86% and 1.17 year payback for their EDRMS project (Nucleus Research, 2004); Salford City Council in UK reporting 15%-20% improvement in productivity in Council Tax and Benefits processing, 75% reduction in absence due to sickness and improved employee satisfaction and motivation after rolling out electronic records and enabling workers to work from home (Salford City Council, 2005).

One of the most famous examples of strategic information systems, Economost, is an example of an electronic order entry system, whose benefits for McKesson, a drug wholesaler, have been documented in prominent academic literature (Clemons and Row, 1988). Though Economost was not an EDMS or even ERMS, it was similar to EDMS in the sense that it reduced/eliminated hand-written paper orders. It is credited with at least playing a role in the following: reduction in order entry or transaction costs, reduction in prices for the customer, reduced order entry errors, improvement in operations such as: reduction in number of telephone order-taking clerks from 700 to 15, reduction in number of sales personnel by 50%, and strategic landscape effects such as drug wholesaler industry consolidation and reduction in the number of direct sales of drug manufacturers to drugstores.

Another technology namely CAD (Computer-Aided Design) also represents a significant technological achievement responsible in large part in helping the architectural community transition from the paper-based world to the electronic age (and in that respect similar to EDM). The case study of Dyer/Brown (Sviokla and Keil, 1991) demonstrates how the use of CAD by the firm led to significant improvement in productivity and to opening of strategic business opportunities to enter new areas (Fichman, 2003). In their study of the business value of EDI (Electronic Data Interchange), Mukhopadhyay et al (1995) assess the additional savings from electronic document preparation and transmission of $40 per vehicle, resulting in millions of dollars of total savings. Despite the above body of research, the amount of high-quality empirical research that uses primary longitudinal data and controls for other confounding factors remains low specifically in the context of electronic document management. This particular research attempts to fill that void by empirically assessing the impact of EDM using four complementary

methods: 1) extensive on-site observation and interviews, 2) detailed time use records, 3) office-wide surveys, and 4) accounting data on multiple intermediate and final performance metrics. We are able to address the following questions: what are the net time savings, if any, that are attributable to EDM? What is the task level impact of EDM? How does that task-level impact translate to performance gains? More generally, we try to answer the following questions: What is the impact of digitizing work on tasks at the information worker level? How does the task-level impact of IT translate to productivity gains? What are the micro-mechanisms that lead to IT payoff?

In clarifying the scope of this IT impact research study, the answers to three basic questions addressed by business value of IT studies – *what* is measured, *how* is it measured, and *where* is it measured (Kohli and Devaraj, 2003) – are as follows: *what*: we focus on the productivity and cost impact of IT, *how*: we gather longitudinal cross-sectional or panel data to assess the causal impact of IT, *where*: we do our analysis at the level of an individual and at the office-level within a single firm. We focus on the efficiency (vs. effectiveness) formulation of performance (Melville et al, 2004) i.e. we focus on an internal perspective that emphasizes metrics such as cost- and time-related efficiency. In other words, we look at the *efficiency* impacts and not the *competitive* impacts of the technology (Melville et al, 2004). Ours is an empirical study (vs. conceptual, theoretical or analytical) (Melville et al, 2004) that combines both qualitative and quantitative research to assess the business value of a specific application at the process and business unit level. Given the importance of the difference between intermediate-level performance measures such as inventory turnover and organizational measures such as market

share (Barua et al, 1995), it is important to clarify that we focus on intermediate process-level performance measures.

Kohli and Devaraj (2003) do a meta-analysis of several firm-level IT impact empirical studies and make several recommendations for future IT payoff studies, including use of primary data and use of larger samples of panel data to assess lagged effects of IT. Though their recommendations are made in the context of firm-level studies, we believe that the suggestions would apply well to even single-firm in-depth field research studies. In an effort to improve our understanding of the true impact of IT, we gather detailed primary data from eight offices in a large insurance company that rolled out the enterprise technology during the course of the study. Our data is also cross-sectional time series that allows us to assess the lagged effects of the new technology. Longitudinal data analysis had been recommended by many researchers to deepen our understanding of the impact of technology (Lucas, 1993; Brynjolfsson and Hitt, 1996; Dewan and Min 1997). There is some longitudinal research that looks at the impact of IT on performance (see examples in McAfee (2002): impact of automatic call planning system on salesperson performance (Fudge and Lodish, 1977), impact of novel point-of-sale systems on amount of material waste in fast-food restaurants (Banker et al, 1990) and impact of access to central information system of insurance carrier on insurance agent performance (Venkatraman and Zaheer, 1994)). However, as McAfee (2002) points out, the body of this research is small, and the magnitude of positive effects of IT shown in it is not substantially large. Further, much of this research is unable to say definitively whether either business process changes or information technology implementation caused the demonstrated effects (McAfee, 2002). Since we have access to a quasi-experiment in this study, our analysis of longitudinal data here is able

to isolate unbiased estimates of the causal effects of information technology. Lack of consideration of lag effects has been pointed as a potential reason for the observed productivity paradox (Brynjolfsson and Hitt, 1996). Though there are a few studies that have analyzed primary longitudinal data and looked at the effects of specific IT applications over time (see for example, Peffers and Santos 1996; Devaraj and Kohli, 2000), given the diversity of IT applications, more research that uses primary longitudinal data to assess the trend of IT payoff or the lagged effects of IT is highly desirable. It is in this vein that our field research study contributes in one of many ways to the IT impact literature.

In accordance with the tool view of technology (Orlikowski and Iacono, 2001), the IT artifact in the IT impact literature is often assumed to lead to the consequences intended by the designers and the managers. This can often limit understanding of unintended consequences of the technology (Markus and Robey 2004). Our four-pronged research study allows us to assess the holistic impact of IT, including some of the unintended consequences of the new technology.

The impact of IT at the enterprise level can be measured more accurately by examining its contributions at the intermediate or process level (Barua et al 1995; Mukhopadhyay et al 1997b; Tallon et al 2000) where first-order effects may be observed since IT is often implemented in support of specific activities and processes (Ray, Muhanna, Barney 2005). Further, a deeper understanding of IT impact can be obtained by looking at the impact of individual IT applications on specific processes and tasks (Mukhopadhyay 1997b, Athey and Stern (2002)). At the firm level, the real impact of IT may be obscured because of aggregation problems: some applications may have a positive impact on certain tasks and processes, while others may have

negative impact on those tasks and processes (Kauffman and Weill 1989; Mukhopadhyay 1997b). The aggregation issues at the firm level combined with the fact that most investment decisions are made at the application level, it becomes important to look at the impact of individual IT applications (Mukhopadhyay 1997b). Our research contributes to the IT impact literature by looking at the impact of a specific IT application, EDM, not yet sufficiently examined in the existing economics of information systems literature and an application particularly important for information workers. Further, we contribute methodologically to the process perspective in the IS literature by using time use studies and differences-in-differences econometric analyses to assess the micro-level impact of EDM at the activity and process level. There are several research studies that analyze pre- and post-introduction of IT data to quantify the impact of IT. For example, McAfee (2002) and Cotteleer and Bendoly (2006) use pre vs. post analysis to look at the impact of ERP (Enterprise Resource Planning) application on process output or operational variables such as lead time. Mukhopadhyay et al (1997a) use pre vs. post analysis to look at the impact of IT on labor productivity in toll collection (or specifically labor hours to complete different types of toll transactions). Athey and Stern (2002) present a differences-in-differences analysis of the impact of IT (in their case enhanced 911 technology) on the timeliness of emergency responses. Given the spectacular variety of IT applications and the great need to document the precise causal impact of IT at a micro-level, there is a dearth of application-specific differences-in-differences empirical studies. Our research study contributes to the IT impact literature by doing a rigorous differences-in-differences econometric analysis of the impact of EDM. Further, in documenting the impact of digitization of work, we uncover a micro-level mechanism as to how IT can lead to payoff in terms of higher performance.

2 Theory and Hypotheses

The motivation and theoretical basis of our work stems from the explanation offered by Autor et al (2003) for the observed skill-biased technical change or the "computer-skills" complementarity, which is the strong correlation between computerization and demand for higher-educated or college-educated labor. The theoretical task model (Autor et al, 2003) is at the core of this research. According to the model, computerization has differential impact on different types of tasks. There are two types of tasks: routine and non-routine tasks. Routine tasks are those tasks that can be specified using a programmable set of instructions. Non-routine tasks on the other hand cannot be explicitly coded as a set of logical instructions, as the rules for performing these tasks are not clear. Routine and non-routine tasks are further classified as manual and analytic tasks. Examples of routine manual tasks include sorting and repetitive assembly, whereas routine analytic tasks include repetitive information-processing tasks such as calculations and record-keeping. Examples of non-routine manual tasks include driving a vehicle, cleaning, and mopping whereas non-routine analytic tasks include problem-solving and complex communications (Autor et al, 2003). Autor et al (2002) describe the kind of tasks that computers can do well: computers can perform tasks that can be fully described using procedural or rules-based logic i.e. "If-Then-Do" type of logic, which specifies the sequence in which tasks should be performed and what tasks need to be performed at different contingencies. Computers can however solve only "known problems"; they are not very good at responding to unexpected contingencies and they still do not have the capacity to do higher-order analytical and cognitive tasks that humans are good at (Autor et al 2002). The above-described task categorization is similar to the classification of decision types in an organization described by Simon (1960).

According to Simon, three are two types of decisions: programmed and nonprogrammed. Programmed decisions are decisions that are routine and repetitive and hence automatable by computers and nonprogrammed decisions conversely are non-routine and often not previously encountered and hence not easily automatable by computers. In leveraging Simon's classification to create a useful framework for information systems, Gorry and Morton (1971) use the terms "structured" and "unstructured" decisions for "programmed" and "nonprogrammed" decisions respectively. We choose to use the task framework as the theoretical grounding for our work here for the following reasons: it classifies tasks versus decisions and we study impact of EDM technology on task input; the Autor classification is a newer and more fine-grained classification of tasks than the decisions categorization: the further classification of routine and non-routine tasks into manual and analytic tasks is a useful one for our purposes here.

Given the task framework and a description of the tasks that computers can do well, computerization and in our case digitizing work would have substantial substitution impact on routine tasks, both manual and analytic (Autor et al 2003). Computerization also "informates" (Zuboff, 1988) or in other words provides vast amounts of rich informational inputs, which can be very useful to information workers who typically have to employ higher-order cognitive skills to process the available information and make sense out of it. In this sense, computers complement information workers in their non-routine analytic tasks and can help them improve their productivity. As a concrete example, consider the availability of comprehensive online bibliographic searches for legal research: though this facility has greatly increased the

information available for consumption, it has undoubtedly also positively impacted the quality of the research (Autor et al 2003).

With falling prices of computer technology and the strong substitutability of programmable tasks, there are economic pressures to substitute computers for humans in those routine tasks (Autor et al 2002). In their study of impact of digital check imaging on check processing at a bank, Autor et al (2002) demonstrate the loss of programmable or "routine" jobs held by high-school graduates when the new technology is introduced. At the same time, due to the strong complementarities between computerization and non-routine analytic tasks, increasing digitization of work should lead to higher demand for non-routine analytic labor input. Autor et al (2003) demonstrate at the *industry level, occupation level and education group level* that computerization is associated with reduced labor input of routine tasks (both manual and cognitive) and increased labor input of nonroutine cognitive (or analytic) tasks. We demonstrate in this research the same effect at the *individual information worker level* i.e. we demonstrate using a detailed empirical study how digitizing work changes task composition at the individual level. We test the hypothesis that digitization of work would lead to a decline in the substitutable routine labor input and an increase in non-routine cognitive labor input at the information worker level. Thus, we test whether non-routine cognitive labor input is a complement to digitization of work at the information worker level. From the production function standpoint, we test at the *individual* level whether "outward shifts in the supply of routine informational inputs [made available thanks to computerization], both in quantity and quality, increase the marginal productivity of workers performing nonroutine tasks that demand these inputs" (Autor et al 2003, p. 1285).

In our field research setting, we examine the impact of introduction of EDM on the task composition at the individual level. Prior to EDM, the information workers in our setting would need to supply a significant amount of routine labor input for their work. Pre-EDM, the information workers would need to type verbatim large sections of documents such as medical reports that were available only in paper form. Post-EDM, the paper documents were all scanned and made available in the electronic form. This obviated the need for the information workers to transcribe the paper documents. Thus, EDM directly impacted the supply of routine labor input, which was substituted away by the document management technology. Further, pre-EDM information workers would transcribe only certain sections of the documents that they deemed salient for their work purposes i.e. information in the paper documents was not completely captured. Information workers exercised significant discretion in deciding which pieces of information to type in verbatim into the information capture system, simply because there was not enough time in the day to transcribe complete copies of the documents. Information workers would apply different lenses to look at the same document. Thus, pieces of information interpreted to be important by one information worker may not be captured by another worker, who interpreted them to be less important. The incomplete information entered into the system was thus of a lower quality. Post-EDM, complete copies of the documents were available in electronic form. No information was lost. In other words, post-EDM, both the *quantity* and *quality* of routine informational inputs significantly increased. Since we hypothesize that increased supply of routine informational inputs should improve the marginal productivity of the information workers who demand these inputs for their non-routine cognitive tasks (Autor et al 2003), we test the impact of shift in task composition of the workers on productivity and

performance metrics. Viewed slightly differently through the framework of managerial activities presented by Anthony (1965), we demonstrate how "operational control activities" (that are concerned with carrying out specific tasks such as verbatim transcription of medical reports effectively and efficiently) are substituted away by EDM technology and more time is made available for "management control activities" (that are concerned with making sure that appropriate resources are obtained and used effectively and efficiently to achieve organization's objectives). Importantly, as mentioned by Gorry and Morton (1971), management control activities often involve interpersonal interaction and calls upon judgment of people, whereas operational control activities involve much less judgment of people. This difference leads operational control activities to be more likely to be automated than management control activities or in other words to their higher inherent substitutability.

In demonstrating a task shift at the information worker level, we also unpack the black box of IT impacting productivity and performance. We uncover a new mechanism as to how exactly IT can lead to significant payoff, especially in terms of information worker productivity. A prominent model of IT payoff that tries to explain the mechanisms that lead to payoff from IT investments from a process point-of-view is the one proposed by Soh and Markus (1995). According to this model, investments in IT applications, skills, and projects represent creation of IT assets, which in turn if successfully deployed lead to IT impacts such as improved coordination and decision-making, and IT impacts at strategic points in the organization lead to higher organizational effectiveness (Soh and Markus, 1995; Devaraj and Kohli, 2000). It is well known that IT can help reduce cost, improve quality, or increase revenues; however, the micro-level mechanisms as to how IT helps achieve those impacts are often unclear. We show how IT can reduce time spent

on certain activities and in reducing the time to complete those tasks, how it makes time available to do other value-adding tasks that involve interaction and higher-order cognitive and analytic skills. Without the introduction of IT, there would not be sufficient time to "pack" in many value-adding tasks in the workday. The routine labor tasks may often be necessary to do the non-routine labor tasks i.e. the routine labor tasks may not be ignored to make time for additional non-routine labor tasks. However, with the deployment of IT, some "slack" may develop, which would allow the information worker to "pack" in more units of value-adding tasks. This "IT-enabled slack" is the new construct that we propose to add to the literature. "IT-enabled slack" can lead to productivity enhancements in two distinct ways: first, as described above, the slack allows information workers to spend more time on value-adding activities. These activities directly lead to productivity and performance improvements. Secondly, "IT-enabled slack" may allow for more personal time relaxing/resting at work or at home (less overtime), which in turn may lead to improvements in productivity (Hamermesh, 1990). Just as Hamermesh (1990, p. 132-S) claims, "additional time spent in on-the-job leisure at least partly represents unproductive shirking rather than productive schmoozing," it is unlikely that all of the "on-the-job leisure" is productively used. That claim notwithstanding, from our interviews and econometric analyses, it does seem that the additional on-the-job leisure time leads to less stressed-out, happier and more productive employees.

We present below a couple of mathematical models to capture the essence of the insider econometric study. The models are simple adaptations of the standard consumer choice model in economics.

In our case, the information worker must choose from a set of activities {1, 2,…, n} available to him at work. Each activity has a 'time price' associated with it i.e. the information worker needs time to complete the activity. Activity 1 requires time t_1, activity 2 requires t_2 and so on and so forth. Let $t_1, t_2, \ldots, t_n$ represent the time required to complete one unit of activity 1, 2, …, n respectively. Let $x_1, x_2, \ldots, x_n$ represent the number of units of activity 1, 2, …, n respectively chosen by the information worker. Assume x_i is single-valued i.e. assume x_i is a function of vector **t** and scalar T, where $\mathbf{t}=(t_1,t_2, \ldots, t_n)$ and T is the total time at work available to the information worker. Also assume that x_i is differentiable in each of its arguments.

Let the activities be divided into two sets of activities: routine activities substitutable by computers, and non-routine cognitive activities that are not easily substitutable by computers. EDM affects the routine activities {1, 2, …, m} where m < n. For those activities, EDM reduces the time associated with those activities i.e. EDM reduces $t_1, t_2, \ldots t_m$. On the other hand, EDM does not impact the non-routine cognitive activities {m+1, ….n} i.e. EDM does not impact t_{m+1}, …t_n. For simplicity, we will assume that EDM does not introduce any new activities for the information worker.

We impose the natural restriction that information workers use up all their time doing their activities (note that we have at-work leisure activities as part of the set of work activities) i.e. we have the following equality (analogous to Walras' Law in Cosumer Choice Theory):

$$\mathbf{t}\,\mathbf{x}(\mathbf{t}, T) = T$$

i.e. $t_1x_1(\mathbf{t},T) + t_2x_2(\mathbf{t}, T) + \ldots + t_nx_n(\mathbf{t}, T) = T$

EDM produces a change in $t_1, t_2, \ldots t_m$; hence, differentiate the above equality w.r.t. t_j where j = 1, 2, …, m:

$$\frac{\partial}{\partial t_j}[t_1 x_1(\mathbf{t}, T) + t_2 x_2(\mathbf{t}, T) + \ldots + t_j x_j(\mathbf{t}, T) + \ldots + t_m x_m(\mathbf{t}, T) + t_{m+1} x_{m+1}(\mathbf{t}, T) + \ldots + t_n x_n(\mathbf{t}, T)] = 0$$

$$\text{i.e. } x_j(\mathbf{t}, T) + \sum_{i=1}^{n} t_i \frac{\partial}{\partial t_j} x_i(\mathbf{t}, T) = 0 \quad \ldots (1)$$

With EDM, the information worker consumes fewer or same number of units of routine activities {1, 2, …, m} (assume here *no change* in number of units of routine activities, so $\frac{\partial}{\partial t_j} x_j(\mathbf{t}, T) = 0$) and re-arranges the 'consumption' bundle of other activities to consume more of those activities.

Multiplying every term on the LHS and RHS of (1) by $(\frac{t_j}{T})$ and the second term on the LHS by $(\frac{x_i}{x_i})$, we have the following:

$$(\frac{t_j}{T}) x_j(\mathbf{t}, T) + \sum_{i=m+1}^{n} t_i(\frac{x_i}{T})(\frac{t_j}{x_i})\frac{\partial}{\partial t_j} x_i(\mathbf{t}, T) = 0 \quad \ldots (2)$$

(2) can be written as follows:

$$(\frac{t_j}{T}) x_j(\mathbf{t}, T) + \sum_{i=m+1}^{n} t_i(\frac{x_i}{T})(\frac{t_j}{x_i})\frac{\partial}{\partial t_j} x_i(\mathbf{t}, T) = 0$$

i.e.

$$b_j(t, T) + \sum_{i=m+1}^{n} b_i(t, T)\ \varepsilon_{ij} = 0 \quad \ldots (3)$$

where $b_j(t, T)$ is the share of total time spent on activity j, and ε_{ij} is the 'cross-time-price elasticity' of activity i w.r.t. time required to do activity j. If EDM reduces t_j and assuming x_j stays unchanged, then the first term in (3) captures the 'IT-slackening effect' (analogous to the 'wealth effect' in consumer choice theory). In one sense, EDM makes the information worker 'richer' in terms of time available to do non-routine cognitive activities. The second term in (3) represents the substitution effect, as the information worker rearranges the activities in the consumption bundle to consume higher units of non-routine cognitive activities.

In the terms of the utility-maximizing information worker, we assume that the non-routine cognitive labor activities offer higher utility than routine labor activities. Let L_R represent the units of routine labor input and L_C represent the units of non-routine cognitive labor input (assume no other activities; at-work leisure activities may be considered to be part of L_C without affecting model/results). Assume, the utility function of the information worker is a Cobb-Douglas utility function represented by $U(L_R, L_C)$.

$U(L_R, L_C) = L_R^{\alpha} \; L_C^{\beta}$, where $\beta > \alpha$

Further, let T_R and T_C be the total time taken on 1 unit of routine labor activity and 1 unit of non-routine cognitive labor activity respectively. The information worker's problem is to maximize his utility function subject to the following constraints: total time spent on routine and non-routine cognitive labor activities should be less than or equal to the total time available at work (T), and he should do a minimum number (η) of routine activities i.e. the information worker cannot simply ignore routine labor activities. The information worker's problem can be represented simply as the following constrained optimization problem with two constraints:

$$\max_{L_R,\, L_C} U(L_R, L_C)$$

s.t. $L_R T_R + L_C T_C \leq T$

and $L_R \geq \eta$

Taking natural logs of the utility function, we have the Lagrangian (L) for the above problem.

L: $\alpha \ln L_R + \beta \ln L_C + \lambda_1(T - L_R T_R + L_C T_C) + \lambda_2(L_R - \eta)$

We have the following Kuhn-Tucker conditions:

$$\frac{\partial L}{\partial L_R} = 0 \text{ -> } \frac{\alpha}{L_R} + \lambda_1 (- T_R) + \lambda_2 = 0$$

$$\frac{\partial L}{\partial L_c} = 0 \text{ -> } \frac{\beta}{L_c} + \lambda_1 (- T_C) = 0$$

$$\lambda_1 \frac{\partial L}{\partial \lambda_1} = 0 \text{ and } \lambda_1 \geq 0 \text{ and } \frac{\partial L}{\partial \lambda_1} \geq 0$$

$$\lambda_2 \frac{\partial L}{\partial \lambda_2} = 0 \text{ and } \lambda_2 \geq 0 \text{ and } \frac{\partial L}{\partial \lambda_2} \geq 0$$

Intuitively, we know that both constraints will be binding. Therefore complementary slackness implies $\lambda_1>0$ and $\lambda_2>0$. We simply have the following expressions for L_R and L_C:

$$L_R = \eta \text{ and } L_C = \frac{T - \eta T_R}{T_C}$$

With EDM, T_R declines and L_C increases i.e. with EDM, time to do routine activities declines, resulting in slack, which in turn allows the worker to focus on the utility-enhancing (as well as productive) non-routine cognitive activities.

3 Research Methodology

We used a four-pronged research study to holistically assess the impact of EDM technology: pre- and post-EDM unstructured interviews, time use studies, structured questionnaires and importantly analysis of office-level objective performance and cost data.

We got access to a large workers compensation insurance company that rolled out EDM technology at different offices at different points in time. Although we conducted informational interviews at several offices of the company, our primary research site was a single large office,

where we focused most of our energies. At that location, we conducted unstructured interviews to understand qualitatively the impact of EDM. The face-to-face interviews were conducted both pre- and post- introduction of EDM. They not only helped us to generate questions for the structured surveys and to ensure that we had a reasonably complete list of activities for the time use studies, but they also allowed us to understand the behavioral impact of EDM on the employees in the office. Quantitative analysis of data obtained from time use studies, surveys as well as other sources is highly useful, but it needs to be balanced with qualitative insights obtained from interviews. Many of the benefits/costs of EDM can be perceived immediately by the information workers and the interviews can be a highly useful instrument to understand from the individual employee perspective what are the perceived benefits/costs of using EDM.

Next, we performed two time use studies each done at three different points in time (one pre-EDM and two post-EDM): one at the office level in which the entire office participated and one at a much smaller scale, in which all case managers working on claims related to a single corporate customer were observed by a single researcher. These time use studies helped us to assess the impact of EDM on the time allocated by employees to various work and non-work activities during the work day. Importantly, this micro-level time use data helps us to evaluate the impact of EDM on efficiency captured in terms of net time savings i.e. it helps us to answer the question: what are the net time savings attributable to EDM? The justification for doing both a larger and a smaller, more focused time use study was the following: The office-wide time use study provides a reasonably large sample of activity profiles pre- and post-EDM for comparison purposes. However, the observations in this larger time use study are self-observations i.e. they are taken by the information workers themselves. It is quite possible that all the employees that

participated in the office time-use study did not use the same standard to record the activities. This can introduce a degree of error or inaccuracy in the results. Also, self-reported time use data relies on understanding, diligence and honesty of the workers (Donahue et al, 2001) and this makes the approach somewhat disadvantageous. Further, it is important to gather qualitative, personal insights into how EDM impacts the allocation of time at the individual employee level. To achieve this objective, we did a much smaller time-use study for a group of information workers that was observed personally by the same researcher. Since the observations are taken by one individual, calibration (i.e. measuring against a standard) errors should be minimized. Further, qualitative insights into how EDM impacts work can be obtained through this process. However, there are some disadvantages to doing direct monitoring, including the significant expense to monitor a large sample and high level of intrusiveness as another party is observing the workers (Donahue et al, 2001).

We also administered a structured questionnaires pre- and post-introduction of the technology. The data collected through the survey instrument helped us to assess quantitatively and qualitatively the *perceived* impact of EDM on various dimensions of importance such as amount of paper, time spent on various activities and communication patterns. We sought to validate results from time-use studies and interviews by asking the consumers of the technology what their experience has been with the technology.

Though survey results are subject to response bias or "social desirability bias" (Stinson, 1999) (i.e. when the respondents answer the questions according to how they think they should respond rather than according to their true experience/beliefs), our survey questions are worded in a way such that they are not leading in a significant way. So, probability of response bias is minimized.

We are cognizant of the fact that employees may perceive things differently from reality. However, survey data of this form is still useful in assessing the direction of impact, if not the magnitude of the impact, of the technology. Also, large number of responses should help improve the statistical reliability of any averages that we compute in the analysis of the survey data.

Finally, differences-in-differences econometric analyses on the objective performance and cost data at the office level allowed us to isolate the causal impact of EDM on various bottom line performance and cost metrics. Time use studies help us to assess how EDM impacts the distribution of work activities at the individual level. The survey instrument helps us to look at the perceived impact of EDM on various metrics from the point of view of the individual employee. How does the impact on distribution of activities translate to an impact on objective metrics used by Liberty Mutual to assess the performance of the offices? If we can isolate the impact of EDM on those metrics that is consistent with observed impact on individual work (seen through the time use studies) and with perceived impact on various measures and communication patterns (available through the survey instrument), then the results from the time use studies and surveys assume increased significance. Combining the results of the econometric analyses with results from analysis of data collected from interviews, time-use studies and questionnaires allows us to understand the true impact of EDM on productivity and performance.

4 Data Collection

Since we were interested in the impact of EDM on information work, we focused our energies in our data collection and analysis efforts on the main information workers in the workers

compensation division of the insurance company (whose name is withheld for confidentiality purposes). These information workers are called *case adjusters* or *case managers* and they handle insurance claims related to injuries suffered by employees on the job. The case managers refer to the injured employee as the *claimant* and the company in which the injured employee (IE) works and which has a service contract with the insurance company as the *customer*.

4.1 Interviews

We conducted 17 unstructured interviews pre-EDM and 20 interviews post-EDM at various organizational levels (Operations Manager, Claims Manager, Team Manager, Case Manager, Nurses) in the office. Pre-EDM interviews were conducted in the last week of March (2006) and post-EDM interviews were conducted in the fourth week of August (2006) and the first week of February (2007). During the interviews, we focused on obtaining qualitative insights about the impact of EDM. Specifically, we wanted to know how case managers perceived personal and company benefits/costs of EDM, behavioral effects of EDM and EDM-related process changes, and how any time anticipated to be saved by EDM was re-allocated.

4.2 Office-Wide Time Use Study

The office-wide *self-reported* time use studies were conducted at three different time points (one pre-EDM and two post-EDM) to give us a longitudinal sample of self-captured activity profiles of case managers. Pre-EDM time use study was conducted in the last week of March (2006) and post-EDM time use studies were performed in fourth week of August (2006) and in the first week of February (2007), approximately 4 and 10 months after EDM was implemented in the office (implementation period: April 20-24, 2006).

With assistance from an internal team at the firm, we prepared a complete list of activities (or tasks) that would be performed by the case managers throughout the day. We invited a few managers and case managers to verify that the activity list was reasonably exhaustive. Given that the time use study would be quite disruptive to the office, we did not seek additional time to train the case managers on the activity codes and also did not perform several consecutive days of recording (as suggested by Stinson ,1999). We were actually pleasantly surprised that we had gotten unprecedented access to conduct an office-wide time use study. Our initial plans included doing only a small four case manager time use study.

The individual activity profiles were not anonymous as employees were requested to note their names on the observation sheets. A sample observation sheet is available in the appendix. Details of administration of the office-wide time use study are as follows: first, a meeting of the team managers was called and the details of the time use study were explained. Team managers were assured by the regional office manager as well as the researchers that the time use study was only meant to help assess the impact of the technology on the workplace. Team managers were encouraged in turn to explain the procedure and rationale to the case managers. Next, an excel file detailing the exact observation recording procedure as well as the activity code list was distributed electronically to the team managers, who in turn distributed it to the constituents of their teams, the individual contributors or case managers. On the day of the study, case managers were requested to record their activities every 10 minutes throughout their workday. Ideally we would have recorded every single activity along with start and stop time for each activity (Stinson , 1999); however, that would have been extremely disruptive to the case managers and

in our efforts to minimize the distraction that our recording activity would cause, we decided to request recording of activities only every 10 minutes.

Case managers were asked to record four pieces of information for each observation: approximate time of observation, category code (9 category codes capture main categories of activities), activity code (each category contains several activities) and claim step code (17 codes capture the claim step associated with each activity). Ideally, we would have had a small army of researchers observing the case managers in the office throughout the day; however, this was not feasible given finite resources for the research project. Since it is quite possible that despite clear instructions and reasonably accurate descriptions of activities on the coding sheet case managers may have used different codes to record same/similar activities, we requested them to also record for each observation, descriptive details on the activity in the Notes column. This would allow us to correct any miscoded activities, provided the notes column was filled out accurately and with sufficient detail. For missed observations, employees were requested to record MO in the Notes column for that observation. We did not make provision for recording of parallel activities (Kitterod, 2001), which could happen if case managers were multi-tasking at the recording time. To make data collection easier for the case managers, we only asked them to record exactly what they were doing at the time of recording. From the comments that workers wrote in the Notes column, we did not see much evidence of parallel activities. The complete set of category and activity codes for the pre- and post-EDM observations is available in the Appendix.

53 case managers yielded ‘usable’ activity data in the pre-EDM time use study. Case managers were excluded from the data set unless they had at least 40 ‘valid’ observations recorded

throughout the day. 'Valid' observations are those that have both activity code and category code specified. 46 and 56 case managers yielded 'usable' activity data in the post-EDM (t=1) and post-EDM (t=2) study, respectively. However, because of absenteeism or non-availability of case managers due to job training on the day or inability to record at least 40 valid observations, there can be case managers that are not common across the pre-EDM and post-EDM time use datasets. For more usable comparison, we constructed a matched data set that included pre- and post-EDM data from case managers common to the three time use datasets. The matched data set contains 26 case managers. Note that the data was scrubbed where possible to reduce coding mistakes. Since many case managers did not record descriptive details in the Notes column, a coding check was not possible to do on all the recorded activities.

4.3 Four Case Managers/Single Customer Time Use Study

We performed a much smaller *direct observations* time-use study for a group of 4 case managers, all residing in a physical 'pod' configuration and all handling a single customer's account at the office. All four case managers in this time use study were observed personally by one of the researchers. The pre-EDM time use study was conducted in the last week of March (2006) and post-EDM time use studies were performed in the last week of August (2006) and first week of February (2007), approximately 4 months and 10 months after EDM was implemented in the office (April 20-24, 2006). The individual activity profiles were not anonymous. The observation and coding sheets used in this study were identical to those used in the office-wide time use study. The observations here were recorded every 12 minutes instead of every 10 minutes as in the office-wide time use study because only a single researcher was recording observations for all the four case managers in the pod. The time use study yielded a

matched data set for 4 case managers at three points in time: pre-EDM, post-EDM(t=1) and post-EDM(t=2). There are two males and two females in the dataset.

Since case managers are expected to create what is called a 'journal entry' or an electronic record in an IT application called "ExPRS" after completing any significant activity, the journal entries are an electronic trail of their activities and analysis of the journal entry data can yield useful insights into distribution of activities of case managers Specifically, the journal entry data allows us to see the *types* of journal entries recorded by each of the case managers throughout the day. To validate our observations with objectively recorded data, we obtained journal entry data for the four case managers pre-EDM and post-EDM (t=1). This data allows us to cross-check the observational data against hard, objective data recorded by the IT systems at the company. Although we present the results of the analysis of this objective data, it is not to discount the value of the direct observations. In the context of measuring system usage, Rice (1990) mentioned that "while computer-monitored data are empirically more *reliable* measures of system usage than are self-reported data, diaries and observations, they are not necessarily more valid" (p. 641).

4.4 Surveys

We administered to case managers two structured questionnaires (one pre-EDM survey and the other post-EDM survey) consisting of five sections, each containing several questions. The first four sections contained questions for which quantitative data or choice answers were requested. The last section contained open-ended questions written to gather qualitative data. Copies of the surveys are available in the Appendix. The surveys were on the longer side (30 minutes to answer the survey) and were anonymous. The respondents were informed of the goal of the

survey (to understand the impact of EDM on the work practices, communication patterns and performance of employees) and of their rights on page 1 of the survey.

42 case managers responded to the pre-EDM survey. 66 case managers responded to the post-EDM survey. Thus, the pre-EDM survey and the post-EDM survey represented response rates of 57.5% (42/73) and 91.7% (66/72) respectively. The missing survey responses can be attributed to the length of the survey as well as to absenteeism. To increase the response rates for the post-EDM survey, the researchers asked the respondents to certify on a detachable first sheet of the survey that they were completing the survey. The certification page with the name and signature of the employee was detached from the rest of the survey, which stayed anonymous.

4.5 Objective Process Output/Performance and Cost Metrics

We collected cross-sectional monthly data for the performance metrics for eight offices of the insurance company for the time period (Jan 2005 through Dec 2006) i.e. we have for most metrics, 24 months of data for the eight offices, in which EDM was rolled out at several points in time from Oct 2005 through Apr 2006. The specific dates for rollout of the EDM technology in the different offices were:

Office Code: 390 – October, 2005

Office Code: 205 – February 2006

Office Code: 555 – February 2006

Office Code: 471 – March 2006

Office Code: 413 – March 2006

Office Code: 648 – March 2006

Office Code: 608 – April 2006

Office Code: 949 – May 2006

We looked at the following performance metrics:

Current Year Closure Rate: This measures the percentage of claims closed that were opened in the current calendar year.

Previous Year Closure Rate: This measures the percentage of claims closed that were opened in years prior to the current calendar year.

YTD Average Physical Therapy Paid Amount Per Claim: This measures the amount spent per claim on physical therapy costs.

YTD Average Chiropractor Paid Amount Per Claim: This measures the amount spent per claim on chiropractor care costs.

Retention Rate: This measures the case manager retention rate.

YTD Loss Leakage: This measures the total loss payout on the claims. Losses are defined as additional expenses that should not have been incurred on claims if best practices associated with medical management and disability management processes had been properly followed by the case managers.

Rolling12-months TTD Days: This measures the number of days of temporary total disability or number of days that a claimant is absent from work due to a work-related injury and is paid disability benefits.

We also collected cross-sectional monthly data for several cost metrics for the eight offices for the time period (Jan 2005 through December 2006) i.e. we have for most metrics, 24 months of data for the eight offices.

Next-day Air Shipping Costs: Costs associated with shipping of documents via next-day air courier service

Outside Services Fees: Costs associated with claims-related processing services such as claim mail sorting, filing, indexing, and photocopying provided by an on-site vendor

Mailing Services Costs: Costs for mail room operations (covers all departments including claims)

Offsite Storage Costs: Costs associated with off-site storage and maintenance of hard copy records

Incoming 800 number calls costs: Costs associated with incoming 800 number calls

Telephone usage costs: Costs associated with telephone usage at the office

EDM would also be expected to have an impact on overall printing costs; however reliable data on printing costs is unavailable for the various offices, hence we are unable to determine that impact.

5 Data Analysis and Results

5.1 EDM Impact on Time Use: Four Case Managers/Single Customer Time Use Data Analysis

The four case manager time use study yielded a matched dataset of 149 observations pre-EDM, 153 observations post-EDM (t=1) and 175 observations post-EDM (t=2). A detailed pre- and post-EDM activity comparison for the UPS case managers is presented in Table 1. Each of the activities in the table is labeled as part of one of 10 activity groups in column 6: DOC PAPER, ACTIONPLAN, OTH DOC, OTH CASEMGMT, COMM, MEETING, OTH PAPER, EDM, OTH FILEWORK, PERSONAL. These activity groups described below are very useful in the analyses below. Note all % reported in Table 1 are arithmetic means or averages. The total time

spent on each activity group is reported in column 7 (pre-EDM) and column 9 (average of post-EDM (t=1) and post-EDM (t=2)).

From the pre-EDM time-use data, we observe that on average 21.3% of the time of the case managers was spent documenting paper mail and paper faxes (a form of *routine labor input*) (see DOC PAPER activity group in table). Assuming that the case managers work for 8hrs and 15 minutes, this translates to approximately 1hr and 48 minutes or 108 minutes spent daily documenting paper mail & paper faxes. This form of documentation activity disappeared post-EDM as paper documents previously required for the most part to be typed in verbatim were now scanned in and available electronically i.e. 0% of the time post-EDM was spent documenting paper mail & paper faxes. Paper-related activity (excluding documenting paper mail & paper faxes) went down dramatically from 9.1% to 2.1% (see OTH PAPER activity group).

As seen from Table 1, the key result is that the level of documentation activity went down dramatically and time spent documenting seems to have been re-allocated towards significantly higher communication activity (a *non-routine cognitive labor input*). The documentation activity (composed of 'DOC PAPER' and 'OTH DOC' activity groups or specifically, documenting paper mail and paper faxes, writing journal entries, documenting claim screen/details) went down from 31% to 9% (a reduction of 71%), whereas communication activity ('COMM' activity group or specifically phone/voicemail/e-mail activities) or a form of *non-routine cognitive labor input* went up from 28.4% to 39.1% (an increase of 38%). In particular, phone-based communication went up from 22.5% to 31.5% (an increase of 40%). Pre-EDM, a significant percentage of case manager work time was allocated towards posting detailed summaries of medical report and other paper documents to a computer application called 'ExPRS'. The

summaries were captured in the form of what are called ‘journal entries’ and they would often be verbatim copies of important sections of the paper document. Post-EDM, a majority of the paper documents were sent to the scanning service provider for electronic scanning and those documents would no longer be required to be ‘posted’ in a detailed manner to ExPRS journal entry system. Post-EDM, case managers could simply create a short journal entry about the receipt of the document and electronically attach a copy of the EDM document to the journal entry. The journal entries after EDM were reported to be much shorter (perceived to be up to 50% shorter) as case managers were simply linking the electronic documents directly to the journal entries, removing the need to post large portions of the original documents.

Post-EDM, time on other value-adding, non-routine activities involving critical thinking went up. Specifically, time spent on in-person meetings (see ‘MEETING’ activity group in Table 1) went up from 2.5% to 7.0% and time spent on writing/updating action plans (see ‘ACTIONPLAN’ activity group in Table 1) went up from 7.2% to 10.9%.

EDM introduces new activities in the post-EDM time use data. These EDM-related activities identified as part of the ‘EDM’ activity group in Table 1 took 8.3% of the time post-EDM. Of this 8.3%, 4.3% was devoted to new activities that had no close pre-EDM counterparts. Specifically, 4.3% of time was devoted to managing EDM inbox (which much like an e-mail inbox was continuously populated with new documents scanned into the system), uploading documents to EDM (case managers were supposed to upload electronically faxed documents to EDM themselves) and completing EDM document properties (each EDM document had seven identifying properties for case managers to fill in).

Personal activities (see 'PERSONAL' activity group in Table 1) went up from 11.3% to 12.4% (an increase of about 10%). Specifically, the activities in this group were personal break, lunch, and other personal time-off at work. EDM introduces some potentially productivity-enhancing, stress-reducing *slack* that is captured in the increase in the personal activities. Notably, the time use study would fail to capture the time spent at home by case managers on work-related activities such as documenting paper. From interviews, we did find that pre-EDM, many case managers were taking paper documents home to catch up on their document posting activity; however this was eliminated with the introduction of EDM: case managers that we talked to agreed that EDM cut down on overtime as well as on time spent doing office-related work at home.

We graphically present the key results of the activity analysis in figures 1a-1d.

To validate the results based on observational data from the time use study, we next analyzed the computer-captured 'journal entry' data for each of the four case managers for the pre-EDM and post-EDM (t=1) days they were observed. As mentioned earlier, case managers are expected to create what is called a 'journal entry' after completing any significant activity; the journal entries are thus an electronic trail of their activities. The results were striking and validated the observations made by us in the time use study. Specifically, we observed that paper medical report transcription/posting activity (a *routine labor input*) for all case managers dramatically dropped. For all but one case manager, the activity was eliminated post-EDM. This would validate our observation from the time use study that documentation activity dropped

significantly post-EDM. The total number of physician or claimant or customer contact journal entries increased substantially from pre-EDM to post-EDM. In particular, the number of physician contact journal entries increased for all but one of the case managers, the number of claimant contact journal entries increased dramatically for all the case managers and the number of customer contact journal entries substantially increased for all but one of the case managers. This would validate our observation from the time use study that communication activity increased significantly post-EDM.

The results of the analysis on the journal entry data are graphically shown in figures 2a-2e. Note that the "Physician + Claimant + Customer Contacts" figure (figure 2b) aggregates the information presented in the "Physician Only" (figure 2c), "Claimant Only" (figure 2d) and "Customer Only" (figure 2e) figures. The disaggregated information is presented to show that all types of external contacts have in general increased post-EDM.

Next, we compute using the time use data the time savings that may be attributable to EDM and how the time saved is reallocated by the case managers. The net EDM-related time savings from this small case manager study seems to be at least 105 minutes. This corresponds to 20% of 505 minutes available in the entire workday. We arrive at 20% as follows (note gains/losses based on average of post-EDM (t=1) and post-EDM (t=2) compared with pre-EDM): reduction in documenting paper mail & paper faxes (gain of 21.3%), reduction in paper-related activities (gain of 7%), reduction in other documentation activity (gain of 0.7%), and increase in EDM-specific activities (loss of 8.3%).

The 105 minutes saved on account of EDM seems to be reallocated as follows (note average of post-EDM (t=1) and post-EDM (t=2) used below): more time on action plans (see ACTIONPLAN activity group) (19 mins), more time on other case mgmt (such as financial notes (eg. reserving), payments, medical case management activity, recording statements) (see OTH CASEMGMT activity group) (11 mins), more time on communication activity (i.e. phone/e-mail/voicemail) (see COMM activity group) (54 mins), more time on in-person meetings (see MEETING activity group) (at least 15 mins) and more personal time (see PERSONAL activity group) (at least 6 mins). This is shown graphically in figure 3.

5.2 EDM Impact on Time Use: Office-Wide Case Manager Time Use Data Analysis

The office-wide case manager time use study yielded a matched dataset of 2905 observations pre-EDM, 2763 observations post-EDM (t=1) and 3125 observations post-EDM (t=2). The detailed results of the analysis for the matched sample of 26 case managers are shown in Table 2, which shows the arithmetic average of times spent on various activities. We also discuss briefly the results of the mean analysis on the full sample of case managers (not just the matched sample). Since means can be subject to outlier-effects, we also compute medians of times spent on various activities. The median analysis is presented in Table 3. Further, for completeness of analysis, we also show non-parametric analysis (or counts analysis) on the activities in figures 6a-6d. The counts analysis shows the percentage of case managers reporting an increase vs. percentage of case managers reporting a decrease in particular activities. For ease of comparison, we show both pre-EDM and post-EDM statistics in the same table.

Each of the activities in the mean times table (or Table 2) is labeled as part of one of 11 activity groups in column 6: DOC PAPER, ACTIONPLAN, OTH DOC, OTH CASEMGMT, COMM, MEETING, OTH PAPER, RIGHTFAX, EDM, OTH FILEWORK, PERSONAL. Below we discuss the key results (note all comparison statistics below are comparing average of post-EDM (t=1) and post-EDM (t=2) time use data with pre-EDM data).

From the pre-EDM time-use data, we observe that on average 7.8% of the time of the case managers was spent documenting paper mail and paper faxes (a form of routine labor input). Assuming that the case managers work for 8hrs and 15 minutes, this translates to approximately 39 minutes spent daily documenting paper mail & paper faxes (a form of *routine labor input*). This form of documentation activity reduced to 1.8% post-EDM, a reduction of 77%. This is generally consistent with what was observed in the four case manager time use study. However, note that the level of this type of documentation activity was much higher in the four case manager time use study. We of course would not expect the results to be the same across the two time use studies because of several differences between them. For one, there is a significant difference in the sample size (4 versus 26) between the two data sets. Also, the observations were taken by a single researcher in the four case manager time use study, while they were taken by the case managers themselves in the office-wide time use study. Nevertheless, given the significant difference between the two numbers for the documentation of paper mail and paper faxes activity, we sought to understand whether there was any systematic reason for the observed difference. We found out that many case managers were simply *not* posting medical as they did not have enough time at work; they would simply send the paper documents to paper file upon receipt. Many case managers would *not* do medical file posting at work during regular hours:

some would stay overtime or do it at home. This would explain the significantly lower percentage of time spent on file posting observed in the office-wide time use study. Paper-related activity (excluding documenting paper mail & paper faxes) went down dramatically from 7% to 4.8%, a reduction of 31%. This is also consistent with what was observed in the four case manager time use study.

As seen from Table 2, the key result again is that the level of documentation activity went down dramatically and time spent documenting seems to have been re-allocated towards significantly higher communication activity (a *non-routine cognitive labor input*). The documentation activity (composed of 'DOC PAPER' and 'OTH DOC' activity groups or specifically, documenting paper mail and paper faxes, writing journal entries, documenting claim screen/details) went down from 21.3% to 11.5% (a reduction of 46%), whereas communication activity ('COMM' activity group or specifically phone/voicemail/e-mail activities) went up from 26.4% to 32.5% (an increase of more than 23%). In particular, phone-based communication went up from 19% to 22.5% (an increase of 18%). The above results are again consistent with what was observed in the four case manager time use study.

As observed in the four case manager time use study, EDM introduces new activities in the post-EDM office-wide time use data. These EDM-related activities identified as part of the 'EDM' activity group in Table 2 took 7.6% of the time post-EDM. Of this 7.6%, 5.8% was devoted to new activities that had no close pre-EDM counterparts. Specifically, 5.8% of time was devoted to managing EDM inbox (which much like an e-mail inbox was continuously populated with new documents scanned into the system), uploading documents to EDM (case managers were

supposed to upload electronically faxed documents to EDM themselves), completing EDM document properties (each EDM document had seven identifying properties for case managers to fill in) and linking journal entries to EDM documents.

Personal activities (see 'PERSONAL' activity group in Table 2) went up from 10.9% to 13.7% (an increase of 26%). Specifically, the activities in this group were personal break, lunch, and other personal time-off at work. EDM introduces some potentially productivity-enhancing, stress-reducing slack that is captured in the increase in the personal activities.

Time spent on in-person meeting activity went down from 10.9% to 5.3% (decrease of 51%). This is *not* consistent with what was observed in the four case manager time study, where an increase in in-person meeting activity was observed. However, given that all employees, including managers, had online access to documents post-EDM, there would be need for fewer in-person meetings.

We graphically present the key results of the activity analysis in figures 4a-4b. Clearly, communication activity (COMM: phone/e-mail/voicemail) shows increasing trend over time, whereas documenting paper mail & paper faxes (DOC PAPER) and other documentation activity (OTH DOC: documenting impact, writing journal entries, documenting claim screen/details) and other paper-related activities (OTH PAPER) show clearly declining trends over time.

For completeness, we present the mean time use analysis on the full sample of case managers. We have 53 case managers in the pre-EDM time use study, 46 managers in post-EDM (t=1) time use study and 56 case managers in the post-EDM (t=2) time use study. The results are shown in

Table 7. The results are consistent with what is observed in the matched sample. Documenting paper mail and paper faxes (a form of routine labor input) declined significantly. Paper-related activity (excluding documenting paper mail & paper faxes) also went down dramatically. Documentation activity (composed of 'DOC PAPER' and 'OTH DOC' activity groups or specifically, documenting paper mail and paper faxes, writing journal entries, documenting claim screen/details) went down whereas communication activity ('COMM' activity group or specifically phone/voicemail/e-mail activities) went up. In particular, phone-based communication increased. EDM introduced several new activities in the post-EDM state. Personal activities also went up significantly.

Since mean time analysis may be vulnerable to outlier-effect, we computed the median statistic as well. The detailed results of the analysis for the matched sample of 26 case managers are shown in Table 3, which shows the median of times spent on various activities. Each of the activities in the table is labeled as part of one of 11 activity groups: DOC PAPER, ACTIONPLAN, OTH DOC, OTH CASEMGMT, COMM, MEETING, OTH PAPER, RIGHTFAX, EDM, OTH FILEWORK, PERSONAL. All % reported in the table are medians. We show the medians from two time use studies (pre-EDM and post-EDM (t=1)). Below we discuss the key results (note all comparison statistics are comparing post-EDM (t=1) time use data with pre-EDM data).

Time spent doing documenting paper mail & paper faxes activity went to nil post-EDM. Time spent on communication activity (phone/e-mail/voicemail) goes up from 23.7% to 30.6% (increase of 29%). Time spent communicating on the phone goes up from 18.8% to 23.1%

(increase of 23%). Time spent on in-person meeting activity went down from 10.3% to 2.2% (decrease of 79%). Time spent doing personal activities goes up from 9.7% to 14% (increase of 44%). The median analysis results are broadly consistent with the results from the mean analysis.

Next, we perform counts analysis (an example of non-parametric analysis) on the activities. The results of the analysis are shown graphically in figures 6a-6d. In each of those figures, "Increase" refers to the % of all case managers reporting an increase in the activity post-EDM (t=1) and "Decrease" refers to the % of all case managers reporting a decrease in the activity post-EDM (t=1). Please note that the percentages reported for each activity (under Increase and Decrease) in the figures do not add up to 100% because for clarity we do not show percentage of case managers reporting "no change" in that activity. A significant percentage of case managers often may not report any change in the frequency of a particular activity because the activity is missing from both the pre- and post-EDM time use data sets.

Figure 6a shows that number reporting a decrease in documenting paper mail & paper faxes activity as well as writing journal entries greatly exceeds the number reporting an increase in those activities. Specifically, about 65% of all case managers reported a decrease in documenting paper mail/faxes activity, whereas about 23% reported an increase in the same activity and 12% reported no change in that activity. At the same time, the number reporting an increase in documenting action plan/initial assessment activity exceeds the number reporting a decrease in that activity.

Figure 6b shows that the number reporting an increase in phone/voicemail/e-mail activity exceeds the number reporting a decrease in those activities. The number reporting a decrease in

in-person meeting activity greatly exceeds the number reporting an increase in that activity. Figure 6c shows that the number reporting an increase in personal activities (break and lunch) greatly exceeds the number reporting a decrease in those activities.

Figure 6d shows the effect of EDM on various activity groups. Clearly, the percentage of case managers reporting a decrease in documenting paper mail/faxes as well as in other documentation activities greatly exceeds the percentage of case managers reporting an increase. The percentage of case managers reporting an increase in communication (phone/voicemail/e-mail) and in personal activities greatly exceeds the percentage of case managers reporting a decrease. The percentage of case managers reporting an increase in "other case management" activities exceeds the percentage of case managers reporting a decrease. The results of this non-parametric analysis are broadly consistent with the results from the mean and median time analyses.

Next, we compute using the office-wide self-reported time use data the time savings that may be attributable to EDM and how the time saved is reallocated by the case managers. The net EDM-related time savings from this small case manager study seems to be at least 51 minutes. This corresponds to 10.1% of 505 minutes available in the entire workday. We arrive at 10.1% as follows (note gains/losses based on average of post-EDM (t=1) and post-EDM (t=2) compared with pre-EDM): reduction in documenting paper mail & paper faxes (gain of 6%), reduction in paper-related activities (gain of 2.2%), reduction in other documentation activity (gain of 3.9%), reduction in in-person meeting activity (gain of 5.6%) and increase in EDM-specific activities (loss of 7.6%).

The 51 minutes saved on account of EDM seems to be reallocated as follows (note average of post-EDM (t=1) and post-EDM (t=2) used below): more time on communication activity (i.e. phone/e-mail/voicemail) (see COMM activity group) (31 mins), more time on other case mgmt (such as financial notes (eg. reserving), payments, medical case management activity, recording statements of claimants) (see OTH CASEMGMT activity group) (3 mins), and more personal time (see PERSONAL activity group) (17 mins). This is shown graphically in figure 5.

When we examine data from our time use study of four case managers, we find a net time savings of 105 minutes per day attributable to EDM. In contrast, when we analyze data from the office-wide time use study in which we have a matched sample of 26 case managers, we obtain a net time savings of 51 minutes. Each result comes with its own set of caveats: the larger time use study result is based on a larger data sample and hence is potentially statistically more reliable; however, the observations there are recorded by the employees themselves and it is not possible to ascertain that the same standard of judgment has been used to code the various activities. Although we requested case managers to document comments for each of the activities on the observation sheets, the instructions were not always followed. Further, case managers varied in their diligence in recording reasonably detailed comments for the activities. Both of these factors limited our ability to correct mis-codings.

The difference between the net time savings numbers largely stems from the difference in the pre-EDM times spent on documenting paper mail and paper faxes in the two time use studies. While the pre-EDM four case manager time use study indicated that 21.3% of time was spent on documenting paper mail and paper faxes, the office-wide time use study indicated that only 7.8%

of time spent on the same activity. This number is critical to the net time savings calculations. As already mentioned, in our efforts to find out the reason behind the discrepancy, we found out that many case managers were simply *not* posting medical documents as they did not have enough time at work; they would simply send the paper documents to paper file upon receipt. Many case managers would *not* do paper medical document trasnscription at work during regular hours: some would stay overtime or do it at home. These factors would directly impact the time recorded for the particular documentation activity in the pre-EDM state.

The four case manager study, albeit small, is potentially more accurate as all observations were taken by a single person and hence calibration error is minimized. In addition, the pre-EDM survey indicated that the average time spent transcribing paper medical reports was 103 minutes, which was much closer to what was observed in the smaller time use study.

5.3 EDM Impact on Time Use: Survey Data Analysis

The survey provided useful data to triangulate the results of EDM impact on time use as well as data to assess EDM-related time savings that would not be easy to capture through a time use study. According to the pre-EDM survey, the average time spent transcribing paper medical reports was 103 minutes, which corresponded remarkably well with what was observed in the four case manager time-use study. Post-EDM the time spent typing in medical reports declined to 17 minutes, a statistically significant change (Note we tested statistical significance of difference between pre-EDM and post-EDM numbers obtained from the surveys using two-sample unequal variance t-test). Also, pre-EDM the average time spent typing in legal documents was 27.8 minutes, which declined to 13.6 minutes post-EDM. The number of times per week a case manager would need to go to the filing area to retrieve a paper file declined from

6.3 (pre-EDM) to 2.3 (post-EDM), a statistically significant decline. Notably, the time to search for the desired document in the electronic claim file is only 20.7 *seconds* as opposed to 18.2 *minutes* pre-EDM with paper files. The number of paper faxes that a case manager would send per week declined from 9.2 (pre-EDM) to 4.7 (post-EDM), a statistically significant decline. This represents significant time savings as it would be quite time-consuming to prepare and send a paper fax. Pre-EDM, to send a paper fax, a case manager would need to print a fax intro sheet, prepare the sheet by filling out the relevant fields, print the document, attach the fax sheet to the printed document and place the prepared fax in the outgoing fax bin or physically walk to the fax machine to send the document. All of these steps combined would make the activity of sending a paper fax in the pre-EDM world significantly time-consuming. At least 60% of the survey respondents said that post-EDM, the time to send documents to the internal human resources such as field nurses, field investigators, and field legal staff had declined in general because these individuals now had online access to the electronic documents. The above survey results on perceived time savings are broadly consistent with the time savings observed in the time use studies. Further, these results amplify the time savings attributable to EDM obtained through analysis of time use data, as the time use methodology may fail to capture savings such as those related to searching or sending paper faxes.

5.4 EDM Impact on Communication Patterns: Survey Data Analysis

At least 36% of the survey respondents said that post-EDM, the number of times internal human resources such as field nurses, field investigators and field legal staff contacted case managers to send them documents had declined in general because these individuals now had online access to the EDM documents and would not need to call or e-mail the case managers to send them the documents. At least 20% of the respondents said that time spent communicating with doctors

and claimants had increased post-EDM. Since the majority of case manager e-mails/phone calls seemed to be externally bound (i.e. to doctors and claimants), the reduction in calls/e-mails from internal employees does not compensate for the increase in calls/e-mails to external parties. This is consistent with the higher overall level of communication activity (phone/voicemail/e-mail) observed in the time use studies.

75% of the respondents said that post-EDM, number of e-mails received had increased. From the viewpoint of the case managers, this was a negative unanticipated consequence of EDM. With the rollout of the technology, the management at the insurance firm decided to make the work process change that medical providers and other parties interested in faxing documents to the case managers would be encouraged to send all correspondence to the RightFax number. All faxes sent to the RightFax numbers would pop up as e-mails with attachments in the email Inboxes of the case managers. The % of e-mails received from medical providers/doctors had increased from 17% to 28%, a statistically significant change. The % of e-mails received from customers had *decreased* from 41% to 30%, also a statistically significant change.

44% of the survey respondents said that post-EDM, the number of e-mails sent had also increased as case managers now had new ability to conveniently send faxes as e-mail attachments right from their computer desktops.

5.5 Econometric Analyses

As mentioned in the Introduction, we have here in this field research study a large quasi-experiment, in which the time of application of the intervention (in our case the EDM technology) to various entities (in our case the offices) is “as if” it was randomly determined i.e.

in which randomness is introduced by variations in specific office circumstances such as timing of the implementation of the technology that make it appear as if the technological treatment was randomly assigned to the offices. This allows us to use the OLS (Ordinary Least Squares) regression technique to assess the causal impact of EDM by incorporating the treatment variable as a regressor in the model. If the treatment variable is "as if" randomly determined, OLS is an unbiased estimator of the causal effect (Stock and Watson, 2007).

Specifically, we use the differences-in-differences regression technique to isolate the impact of EDM intervention on various performance and cost metrics. Differences-in-differences (D-in-D) is an effective technique to isolate the effect of an intervention/treatment (such as the introduction of a new technology) on the dependent variable of interest. The D-in-D estimator is the difference between the "average change in the variable of interest for the treatment group or the group that received the technological intervention" minus "the average change in the variable of interest for the control group or the group that did not receive the technological intervention." We use time fixed effects as well as office fixed effects in testing whether EDM (or treatment which appears as an independent variable in the regression) has any impact on the performance metric (or the dependent variable). The inclusion of office fixed effects and time fixed effects removes omitted variable bias resulting from exclusion of unobserved variables that vary across offices but are constant over time and variables that vary over time but are constant across offices. The mathematical representation of the general model that we estimate is presented below:

$$Y_{it} = ß_0 + ß_1 X_{it-l} + ß_2 \mathbf{W}_{it} + \gamma_2 D2_i + \ldots + \gamma_n Dn_i + \delta_2 B2_t + \ldots + \delta_{12} B12_t + \eta CY + u_{it}$$

where $ß_0, ß_1, ß_{2,} \gamma_2, \ldots, \gamma_n, \delta_2, \ldots, \delta_{12}, \eta$ are regression coefficients that need to be estimated, i = 1,2,…,n indicates the office, t = 1,2,…, 12 indicates the monthly time period, Y is the dependent variable, X_{it-l} is the binary treatment variable X_{it} lagged 'l' periods (X_{it} equals 1 if office i has received the treatment by time t and zero otherwise), $\mathbf{W}_{it}$ is a vector of pertinent control variables, $D2_i \ldots Dn_i$ are the binary variables for the offices, $B2_t \ldots B12_t$ are the binary variables for the months (to control for seasonal time effects), CY is the binary variable for the calendar year which equals 1 for year 2006 and u is the error term. Note binary variables for office 1 and time period 1 are excluded from the regression model to eliminate perfect multi-collinearity. Also note that the treatment variable in the model is lagged as appropriate, as EDM may have the maximum impact on a particular metric after some time. The lags may differ for different models as EDM may be expected to impact different metrics at different time periods.

We found that introduction of EDM is associated with the following effects on the performance metrics:

1) improvement in ability to meet or beat current year closure rate monthly goals that are dynamic in nature. This effect is observed at a 1-period lag and is statistically significant. (number of observations N=192) (see Table 4a). The logistic regression result implies that EDM increased the predicted log odds of meeting/beating current year closure rate goals by 1.78. Equivalently, EDM multiplied predicted odds of meeting/beating current year closure rate goals by $e^{1.78}$=5.93.
2) increase in the current year closure rate. This effect observed at a 1-period lag is however not statistically significant (number of observations N=192) (see Table 4a). The regression result implies a 0.9% increase in the current year closure rate associated with the implementation of EDM in the offices.

3) decrease in the previous clear closure rate. This effect observed at a 1-period lag is however not statistically significant (number of observations N=184) (see Table 4a).
4) decrease in the YTD avg. amount paid for physical therapy on a per-claim basis. This effect observed at a 3-period lag is significant at the 1% level (number of observations N=176) (see Table 4b). The regression result implies a reduction of $111 or 19% drop in the YTD average amount paid for physical therapy on a per-claim basis that is associated with the implementation of EDM in the offices. Interestingly, we also see higher medical management activity by the case managers. From the analysis of claim steps in the matched sample N=26 time use data, we observe approximately a 19% increase in medical management claim step activity (based on comparison between pre-EDM estimate and average of the post-EDM t=1 and t=2 estimates).
5) decrease in the YTD avg. amount paid for chiropractor care on a per-claim basis. This effect observed at a 2-period lag is significant at the 1% level (number of observations N=176) (see Table 4b). The regression result implies a reduction of $154 or 28% drop in the YTD average amount paid for chiropractor care on a per-claim basis that is associated with the implementation of EDM in the offices. Interestingly, we also see higher medical management activity by the case managers.
6) increase in the claim service team professionals (or case managers) retention rate (see Table 4b). This effect observed at a 1-period lag is significant at the 1% level (number of observations N=168). The regression result implies a 7% increase in the retention that is associated with the implementation of EDM in the offices.
7) decrease in YTD loss leakage (i.e. losses associated with leakage or overpayments when best practices associated with medical management and disability management are not

followed). This effect observed at a 4-period lag is however not statistically significant (number of observations N=176) (see Table 4c). The regression result implies a 4% decrease in the loss leakage that is associated with the implementation of EDM in the offices. Interestingly, we also see higher medical management activity by the case managers.

8) increase in TTD days (12 months rolling average) (i.e. number of days of temporary total disability for which disability benefits have to be provided). This effect is observed at a 4-period lag and is statistically significant at the 5% level (number of observations N=192) (see Table 4c). The point estimate though statistically significant implies only a 2% increase in TTD days that is associated with the implementation of EDM.

The detailed fixed effect pooled regressions are shown in tables 4a-4c. Note that the standard errors reported are heteroskedasticity-robust Huber/White standard errors. Further, note that though we did use office dummies, we do not show the coefficients corresponding to those dummies for sake of confidentiality. The variable names used in the models (see tables 4a-4c) are: EDM TREAT, which is the binary treatment variable appropriately lagged, TOT. STAFF, which is the total claim processing staff strength of the office, INC. CLAIM, which is the total number of incoming claims.

The above effects of EDM on various performance metrics are consistent with expectations. Although the effect of EDM on the current year closure rate is not statistically significant, the point estimate is positive and more importantly the ability to beat current year closure rate goals is positively impacted by EDM (and this effect is statistically significant). Most cases can be

closed when the claimant returns to work in modified duty or full duty positions. Returning the claimants back to work in such positions often requires critical communication on the part of the case managers with all the three key parties involved: medical providers or doctors, customers or the employers of the injured workers and the claimants. We do know from the time use studies that EDM greatly frees up time to do this important value-adding communication activity and we do see level of this activity jump post-EDM. Importantly, most of the current year cases have most of their documents (such as medical reports) in the electronic form. Access to these documents is much easier and faster with EDM. This improves the speed of communications. From the survey, we know from the case managers perspective that one of the top three perceived benefits of EDM is faster access to claim documents (the other two being less time documenting paper mail, and better information sharing with other groups/individuals). Hence EDM would be expected to positively impact the ability of offices to meet/beat their monthly current year closure rate targets.

Just as the effect of EDM on current year closure rate is positive, its effect on previous year closure rate is negative (note the point estimate is negative although the effect is again not statistically significant). Given that previous year closure rate measures the closing of cases opened in years prior to the current year, most of these cases do not have their documents in the electronic form (note that the offices did not attempt to migrate any of the prior year old cases to EDM). Even though some of the freed up time because of EDM would be devoted to increased communication activity related to the older cases, follow-up activity and communication in general is slowed or held up because the documents belonging to those cases are not easily accessible. Hence, EDM would not be expected to positively impact previous year closure rate.

The above findings on closure rates are consistent with findings in previous research, in which adoption of new technologies has been shown to reduce production time in the stage of production where the technology is of value (Bartel et al 2004, p. 220). Further, the positive impact on current year closure rate and the negative impact on previous year closure rate seems to reduce the likelihood of Hawthorne effect, which refers to the effect of observation on people's behavior or performance.

It is interesting to see the statistically significant effects of EDM on physical therapy costs and chiropractor care costs on the claims. The reduction in these costs critically depends on the ability of case managers to manage medical treatment of claimants and ensure that only treatment that is medically necessary is covered. The claim step process that case managers engage in to achieve medical cost savings is technically labeled within the firm as "medical management." Medical management requires timely utilization of various medical resources available to the case managers to manage the medical costs and timely and regular follow-up with treating doctors and the claimants. The regular follow-up allows the case manager to determine whether the claimant is making objective progress. For example, in the context of physical therapy, it is important for the case manager to determine whether the injured worker is making objective progress in the therapy process. In the context of chiropractor care, it is important for the case manager to check whether improvement is evident within two weeks of start of care. EDM frees up time to engage in value-adding medical management, which crucially involves communication activity (note that we see evidence of higher communication activity from the time use studies). Further, from the survey, we know that approximately 48% of the respondents said that time freed up because of EDM allowed them to spend more time to follow-

up on activities outlined in their action plans. Importantly, EDM allows for chronologically sorting of documents that allows case managers to quickly and accurately assess whether objective progress in the treatment program is being made, and if any changes in doctors/medications/therapy would help. The finding that EDM has a highly positive impact on the ability of case managers to reduce physical therapy costs and chiropractor care costs is especially significant in light of data from the interviews in which case managers revealed that pre-EDM they often did not document/post therapy notes into the claim files as they did not have time to do so. Lack of documentation of these notes would make it more likely for case managers to miss important warnings and chances to reduce therapy costs.

The positive effect of EDM on the retention rate of the case managers is also interesting. From the interviews, we do know that EDM has cut down on overtime work for case managers. Also, pre-EDM many case managers would take home work, especially documenting paper mail type of work. The documenting mail work would be perceived as low-skilled "secretarial work" and not the real and more interesting case management work that case managers wanted to do. This could be frustrating to some of the case managers. Post-EDM, this type of low-skilled "secretarial work" was dramatically reduced. EDM also resulted in a dramatic reduction in paper documents sitting on the desks of the case managers. Pre-EDM, the paper documents would simply pile up on the work desk, waiting for the case manager to "work" them. The rising pile of paper documents on the desk would cause mental frustration to the workers. EDM helped case managers stay more organized and removed their feeling of being overwhelmed by all the paper on their desks. Post-EDM, the number of backlogged documents sitting on the desk showed a dramatic drop consistent with the 88% of survey respondents saying that the number of inches of

paper that they were receiving daily had declined. The average number of inches of paper received daily declined from 2.55 inches to 1.92 inches, a statistically significant drop. Based on data from the survey, the distribution of backlogged documents pre- and post-EDM is shown graphically in figure 7. A comparison of the two charts clearly indicates that the distribution of backlogged documents has dramatically shifted to the left (i.e. the number of backlogged paper documents on the desk has significantly declined). Lastly, the time use studies indicate higher level of personal time at work, which would imply lower level of work-related stress. All of the factors above would indicate that EDM made work more pleasant for the case managers, and this is reflected in the positive impact on the retention rate.

Finally, the EDM effects on the loss leakage and the temporary total disability metrics are also interesting. Though the effect on the loss leakage metric is not statistically significant, the point estimate is negative and consistent with expectations. As indicated previously, loss leakage captures the overpayments when best practices associated with medical management and disability management are not followed, where medical management and disability management are technical terms for processes used within the firm to describe case direction that results in medical cost savings and indemnity savings respectively. Controlling or reducing loss leakage critically depends on the ability of the case managers to stay on top of their cases and do continuous follow-up with medical providers, customers and claimants. Communication activity is key and timely assigning helpful resources such as nurses and investigators on the files is paramount to controlling leakage. The freed up time because of EDM allows higher level of value-adding communication activity and more time for thoughtful case management and investigation. Importantly, EDM also allows case managers to chronologically sort documents

and more easily/quickly detect what is known as “injury creep” (similar to “scope creep” in IT projects), in which the treatment currently being paid for is for an injury that is not related to the original *covered* injury at work. Further, EDM makes timely receipt of important documents (such as claimant work status reports from doctors) more likely as external parties such as doctors simply fax them to the e-fax numbers of the case managers post-EDM. This makes it easier for case managers to cut off benefits in a more timely fashion, reducing possible overpayments. Given above reasons, EDM would be expected to reduce loss leakage. The higher closure rate and higher TTD (or number of temporary total disability days for which indemnity benefits are provided) are consistent. Since closure rate is the paramount performance metric, the case managers in their efforts to close out the cases may, after negotiating with the customer (or the employer of the injured worker) and the injured worker, pay out a higher number of disability days.

The fixed effect models yield consistent estimates; however, we might be able to get more efficient estimates by employing a random effects model. We have to, however, check that the random effects coefficients are not systematically different from the fixed effects coefficients, which are consistent. We do this by performing the Hausman test (Hausman, 1978), which allows us to test the null hypothesis that the fixed effects estimates are not systematically different from the random effects estimates. A high Hausman statistic would reject the null hypothesis, in which case we should would retain the fixed effects estimates, which are consistent. If we do not reject the null hypothesis, we would retain the random effects estimates, which are both consistent and efficient under the null. Table 6a shows the coefficients on the EDM TREAT variable obtained using fixed effects and random effects panel data estimation

techniques and the corresponding Hausman statistics. The selected fixed effects or random effects coefficient is highlighted in bold in the table. We performed random effects GLS regressions for the sake of thoroughness, but found no highly notable differences between the fixed effects and the random effects coefficients.

We find that introduction of EDM is associated with the following effects on the cost metrics:

1) increase in next-day air courier costs (an increase of $2875 per month or 151% increase attributable to EDM). This effect is observed at a 1-period lag and is significant at the 1% level (number of observations N=192) (see Table 5a).
2) decrease in outside services fees for claims-related processing such as claim mail sorting, filing, indexing, and photocopying. The magnitude of the decrease is $20174 per month or a 38% decrease attributable to EDM. This effect is observed at a 4-period lag and is significant at the 1% level (number of observations N=120) (see Table 5a).
3) decrease in costs associated with mailing services (decrease of $2552 per month or 14% decrease attributable to EDM). Note that these costs cover all departments including claims. This effect is observed at a 5-period lag and is significant at the 1% level (number of observations N=192) (see Table 5a).
4) decrease in costs associated with offsite storage and maintenance of hard copy records (decrease of $849 per month or 34% decrease attributable to EDM). This effect is observed at a 4-period lag and is significant at the 1% level (number of observations N=168) (see Table 5b).

5) decrease in costs associated with incoming 800 number calls (decrease of $152 per month or 5% decrease observed with no lag; the point estimate is however not statistically significant (number of observations N=192) (see Table 5b)).
6) increase in costs associated with telephone usage (increase of $872 per month or 16% increase observed at a 1-period lag; the point estimate is however not statistically significant (number of observations N=192) (see Table 5b)).

The above effects on the cost metrics are in general consistent with expectations. When EDM was rolled out, all medical documents were required to be mailed next day air to the scanning service provider from the offices. This would have resulted in a spike in next day air shipping costs.

EDM also eliminates much of the paper-related processing that was previously outsourced to the on-site vendor. Thus, costs associated with paper handling would be expected to go down. Clearly, the functions associated with paper file handling, sorting and filing are minimized to a great degree with the implementation of EDM. Labor associated with those functions is substituted away by the new technology. In our main field research site, for example, we saw approximately 60% reduction in the labor force associated with the paper file handling functions. Further, associated with EDM implementation is the business process change that customers and medical providers are now encouraged to fax to case manager “Right Fax” or “e-Fax” numbers and not mail or paper-fax those documents to the offices. Thus, overall costs associated with mailing services should go down.

Paper documents are stored with the scanning service provider only for a short period of time before they are destroyed and closed files shipped to off-site storage service provider are also destroyed after some time. Thus, over time costs associated with offsite storage and maintenance of hard copy records should decrease, as more and more files are available only electronically.

The effect on incoming 800 number calls is uncertain; however it may be reasonably expected to go down as calls from customers might be expected to go down (because they now have access to many of the electronic documents). Consistent with increased phone-based communication activity observed with increased medical and disability management activity, overall costs associated with telephone usage might be expected to increase.

As with the performance or productivity metric regressions, we performed random effects GLS regression with the cost metrics. Table 6b shows the coefficients on the EDM TREAT variable obtained using fixed effects and random effects panel data estimation techniques and the corresponding Hausman statistics. Many of the Hausman statistics reported here are negative, meaning that the variance difference between the fixed effects coefficients and the random effects coefficients is not positive semi-definite. This is likely because of the finite sample that we have, in which the asymptotic assumptions of the Hausman test are not met. When we have such a situation, we just select the fixed effects estimates, which we know to be consistent. The selected fixed effects or random effects coefficient is highlighted in bold in the table. Though we performed random effects GLS regressions for the sake of thoroughness, there are no highly notable differences between the fixed effects and the random effects coefficients.

We now show a simple cost-benefit analysis of EDM at the insurance firm.

Costs:

There were one-time sunk costs associated with the implementation of EDM: business team costs associated with management and coordination of the overall implementation effort of $1.05 million, IT development costs (including development costs, infrastructure costs, etc.) of $4.37 million (over two years 2004 and 2005).

The average recurring IT costs associated with EDM (mostly maintenance and infrastructure costs) are expected to be about $3.12 million (average of 2006-2010 forecasted figures). Further, the variable cost of scanning and indexing medical and non-medical paper documents is expected to be about $3.4 million per year.

Further, there are additional next-day air courier costs attributable to EDM. This works out to about $0.28 million per year (=2875*12*8). There are additional costs associated with telephone usage of $0.08 million per year (=872*12*8). Thus, the total recurring costs associated with EDM is expected to be about $6.9 million per year.

Benefits:

There are many benefits that can be quantified in terms of dollars and many that cannot. Benefits quantifiable in dollars are as follows:

EDM is associated with a decrease in outside services fees for claims-related processing such as claim mail sorting, filing, indexing, and photocopying. This works out to about $1.94 million savings per year (=20174*12*8)

EDM is associated with a decrease in costs associated with mailing services. This works out to about $0.24 million savings per year (=2552*12*8). This would be an overestimate of the actual benefit as the mailing services cost data is for all units, including worker compensation claims, where EDM was rolled out.

EDM is associated with a decrease in costs associated with offsite storage and maintenance of hard copy records. This works out to about $0.08 million savings per year (=849*12*8).

EDM is associated with a decrease in costs associated with incoming 800 number calls. This works out to about $0.01 million savings per year (=152*12*8).

The total $ quantifiable benefits work out to about $2.3 million. Of course, there are many intangible benefits associated with EDM that were hard to quantify in terms of dollars given the data that was available to us. These other benefits would include an improvement in case closure rate, improvement in customer retention because of improved ability to deliver savings in physical therapy and chiropractor care to the customer, and improved case manager retention rate. We would suspect that the dollar value of these hard-to-quantify benefits to be the difference between $6.9 million (recurring costs of EDM) and $2.3 million (recurring $-quantifiable benefits of EDM).

6 Discussion

We have used a four-pronged research study to holistically assess the causal impact of an enterprise IT (EDM) on the workers compensation division of a large insurance firm. Through pre- and post-EDM interviews, time use studies, surveys and importantly analysis of office-level objective performance and cost data, we have qualitatively and quantitatively documented the causal impact of a specific IT application, electronic document management technology, which despite its salience in the context of information management has not been studied much in the information systems field. Through our "insider econometrics" empirical study (Bartel et al, 2004), in which we focused on the operations of a single firm, we assessed the impact of EDM at the process and office level. Insider insights obtained through direct contact with the managers and information workers were key in this type of "insider econometrics" study, as they reduced concerns about endogeneity bias and omitted-variable bias in the results (Bartel et al, 2004). Since we focus on a single firm, the results about digitization of work are applicable to the firm studied and future research may need to study other settings to obtain broader generalizibilty; in any case, we believe that the approach that we employ may be widely applicable in future research.

We demonstrated how EDM changed task composition at the individual level. EDM led to a significant decline in the substitutable routine labor input and an increase in non-routine cognitive labor input at the information worker level. Prior to EDM, the information workers in our setting would need to supply a significant amount of routine labor input for their work: they would need to type verbatim large sections of documents such as medical reports that were available only in paper form. Post-EDM, the paper documents were all scanned and made available in the electronic form. This obviated the need for the information workers to manually

transcribe the paper documents. Thus, EDM directly impacted the supply of routine labor input, which was substituted away by the technology. In reducing the time to complete various routine tasks, EDM made time available to do other value-adding tasks that involved interaction and higher-order cognitive and analytic skills. With the deployment of IT, some “slack” developed, which allowed the information workers to “pack” in more units of value-adding tasks. This “IT-enabled slack” led to productivity enhancements in two distinct ways: first, as described above, the slack allowed information workers to spend more time on value-adding communication activities, which directly led to productivity and performance improvements. Secondly, “IT-enabled slack” allowed for more personal time relaxing/resting at work or at home (less overtime), which in turn led to less stressed-out, happier and more productive employees.

EDM also brought about an outward shift in the supply of routine informational inputs which complemented the non-routine cognitive labor input (such as interactions and communications) in the sense that they increased the productivity of workers performing nonroutine tasks that demanded those inputs. Pre-EDM information workers would transcribe only certain sections of the paper documents that they deemed salient for their work purposes i.e. information in the paper documents was not completely captured. Information workers exercised significant discretion in deciding which pieces of information to type in verbatim into the information capture system, because there was simply not enough time in the day to transcribe complete copies of the documents. Information workers would apply different lenses to look at the same document. Thus, pieces of information interpreted to be important by one information worker may not be captured by another worker, who interpreted them to be less important. The incomplete information entered into the system was thus of a lower quality. Post-EDM, complete

copies of the documents were available in electronic form. No information was lost. In other words, post-EDM, both the *quantity* and *quality* of routine informational inputs significantly increased. This improvement in both the quantity and quality of the routine informational inputs increased the productivity and performance of workers performing non-routine tasks that demanded those inputs. We demonstrated the impact of shift in task composition of the workers on productivity and performance metrics at the office level

Mukhopadhyay et al (1995) have proposed several benchmarks to evaluate IT impact research. The first benchmark is theoretical foundation of the research. Our research has a strong theoretical foundation in the task model proposed by Autor et al (2003), which we described in detail in the Theory section above. The second benchmark concerns methodological issues. Our access to a quasi-experiment which makes available experimental controls alleviates the problem of confounding factors affecting the results. Further, the fact that this is an "insider econometrics" study, in which we gathered insider insights through direct contact with managers and information workers, reduces concern about endogeneity bias and omitted-variable bias in the results (Bartel et al, 2004). The third benchmark concerns modeling issues. Our analysis is at the application level, which eliminates aggregation-related issues associated with firm-level analyses (Mukhopadhyay 1997b). The fourth benchmark concerns the quality of data. We had unprecedented access to gather primary data through firm databases, firm reports and manuals, employee observations and interviews. Given that the firm collected the performance data through fairly-long established methods and used them for appraisals and planning, it is safe to assume that the quality of data is high.

7 Conclusion

We make several contributions in this research study. First, our research contributes to the IT impact literature by documenting the significant impact of a specific IT application, electronic document management, not yet examined sufficiently empirically in the economics of information systems literature despite its salience in the context of information management. Second, we demonstrate using a detailed empirical study how digitization of work changes task composition at the individual information worker level. We also show, at the information worker level, that digitization of work leads to a decline in the substitutable routine labor input and an increase in non-routine cognitive labor input, and that this non-routine cognitive labor input is an economic complement to digitization of work. Third, we unpack the black box of IT impacting performance and uncover a new micro-level mechanism as to how exactly IT can lead to significant payoff, especially in terms of information worker productivity. We show how with the deployment of IT, some "slack" may develop, which would allow the information worker to "pack" in more units of value-adding tasks such as communication activities. This "IT-enabled slack" is the new construct that we propose to add to the literature. Fourth, we contribute methodologically to the process perspective in the IS literature by using time use studies and differences-in-differences econometric analyses to assess the impact of EDM at the activity and process level. Given the spectacular variety of IT applications and the great need to document the precise causal impact of IT at a micro-level, there is a pressing need for application-specific, differences-in-differences quasi-experimental empirical studies. Our research study addresses that need by doing a rigorous differences-in-differences econometric analysis of the impact of EDM technology in a quasi-experimental setting. Fifth, given the diversity of IT applications and the lack of application-specific studies that use primary longitudinal data to look at the

lagged effect of IT, we contribute to the IT impact literature by collecting panel data and analyzing the lagged effects of EDM technology on various performance and cost metrics.

8 Table and Figures

Table 1. Mean Time Use analysis on matched sample N=4 Single Customer Case Managers

*Note all % are means or arithmetic averages.

		PRE-EDM (N=4)					POST-EDM avg of (t=1) (N=4), (t=2) (N=4)	
Org. Category	**Activity**	**cat.**	**act.**	**activity%**	**ACTIVITY GROUP**	**%**	**ACTIVITY GROUP**	**avg %**
Doc	Sorting Incoming Mail	1	1	1.3	OTH PAPER			
Doc	Documenting Paper Mail + Paper Faxes	2	1	21.3	DOC PAPER	**21.3**	**DOC PAPER**	**0.0**
Doc	Documenting Action Plan/Initial Assessment	2	3	6.6	ACTIONPLAN	**7.2**	**ACTIONPLAN**	**10.9**
Doc	Writing Journal Entries	2	4	9.1	OTH DOC	**9.7**	**OTH DOC**	**9.0**
Doc	Financial Notes	2	5	1.9	OTH CASEMGMT	**7.3**	**OTH CASEMGMT**	**9.4**
Comm	Phone	3	1	22.5	COMM	**28.4**	**COMM**	**39.1**
Comm	Voicemail	3	2	1.3	COMM			
Comm	E-mail	3	3	4.7	COMM			
Comm	In-person meeting	3	4	2.5	MEETING	**2.5**	**MEETING**	**7.0**
Comm	Sending Paper Fax	3	5	0.6	OTH PAPER	**9.1**	**OTH PAPER**	**2.1**
Comm	Putting Together Paper Items to Mail / Fax	3	7	0.6	OTH PAPER			
Comm	Manage EDM Inbox (Complete/Forward Notifications)	3	9	0.0	EDM	**0.0**	**EDM**	**8.3**
Filework	Accessing Paper File	4	1	0.6	OTH PAPER			
Filework	File Sorting/Removing Duplicates	4	2	0.0	OTH PAPER			
Filework	Copying Files	4	3	1.3	OTH PAPER			
Filework	Electronic Formwork	4	4	1.3	OTH FILEWORK	**2.6**	**OTH FILEWORK**	**0.6**
Filework	Paper Formwork	4	5	0.0	OTH PAPER			
Filework	Payments	4	6	1.3	OTH CASEMGMT			
Filework	Printing from Systems (ExPrs, EDM, Etc.)	4	7	1.3	OTH PAPER			
Filework	Closing File from System	4	8	1.3	OTH FILEWORK			
Filework	Accessing EDM File	4	9	0.0	EDM			
Filework	Dragging & Dropping documents/right-faxes to EDM	4	11	0.0	EDM			
Filework	Complete EDM Document Properties	4	13	0.0	EDM			
Case Mgmt	RTW Plans	5	6	0.6	ACTIONPLAN			
Case Mgmt	Making decision to accept/reject referral	5	9	0.0	OTH CASEMGMT			
Case Mgmt	Medical Management	5	8	4.1	OTH CASEMGMT			
Case Mgmt	Recording Statements	5	11	0.0	OTH CASEMGMT			
Case Mgmt	Documenting Claim Screen / Details	5	12	0.6	OTH DOC			
Case Mgmt	Reviewing Paper Files	5	13	1.6	OTH PAPER			
Case Mgmt	Reviewing EDM Files	5	14	0.0	EDM			
Personal	Break	6	1	1.9	PERSONAL	**11.3**	**PERSONAL**	**12.4**
Personal	Lunch	6	2	9.4	PERSONAL			
Personal	Other	6	4	0.0	PERSONAL			
Administration	Printing / Stapling Incoming Right Faxes	7	1	0.6	OTH PAPER			
Administration	Drop Filing (both picking out and putting away docs)	7	8	1.3	OTH PAPER			
Other	Other Task	9	1	0.6	OTHER			

Figure 1a. Pre-EDM vs. Post-EDM Time Use (4 Case Manager/Single Customer Pod)

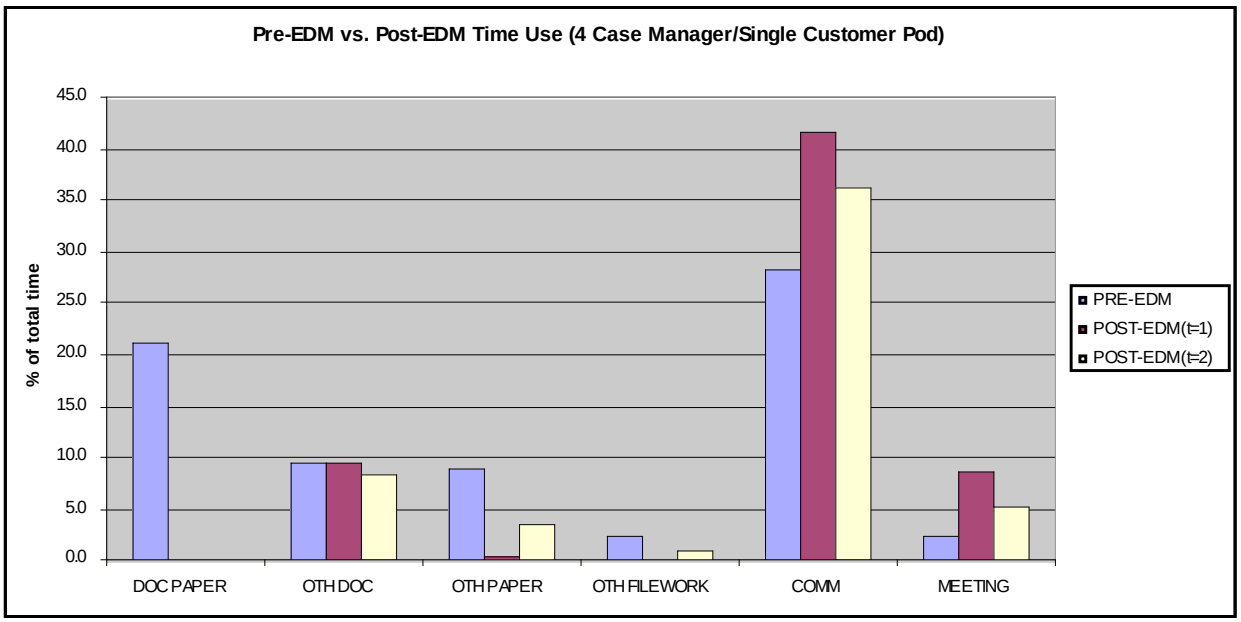

Figure 1b. Pre-EDM vs. Post-EDM Time Use (4 Case Manager/Single Customer Pod)

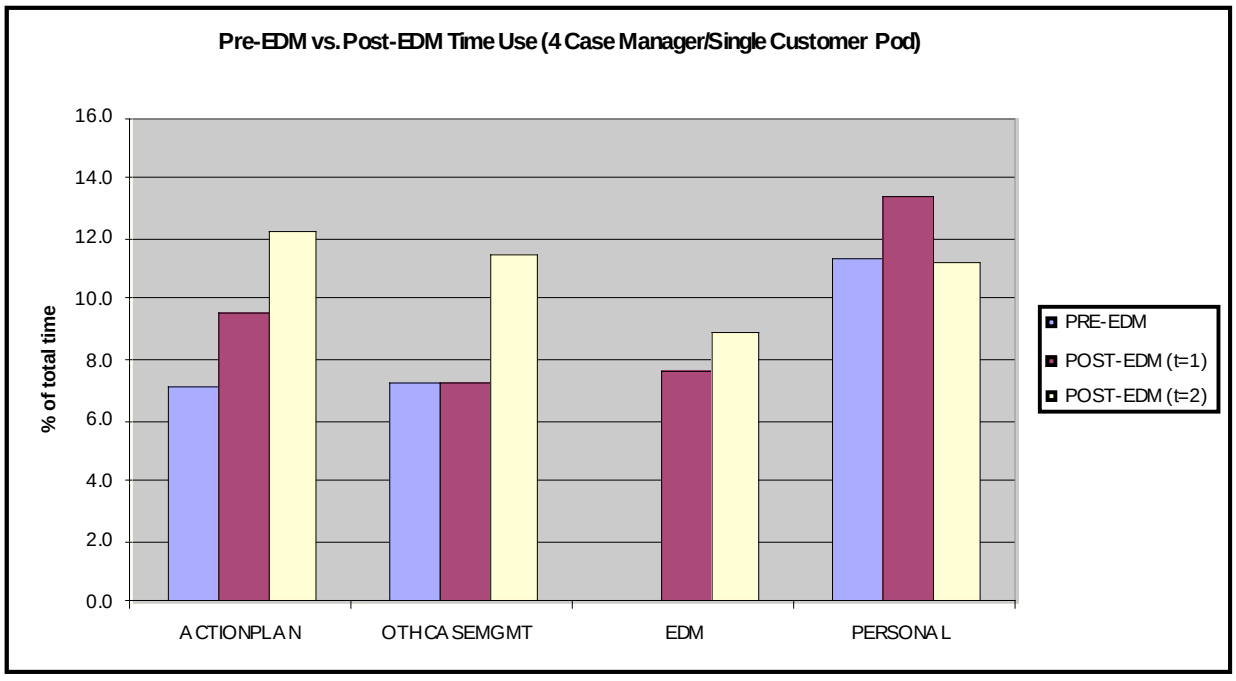

Figure 2a. Pre-EDM vs. Post-EDM Journal Entries (4 Case Manager/Single Customer Pod)

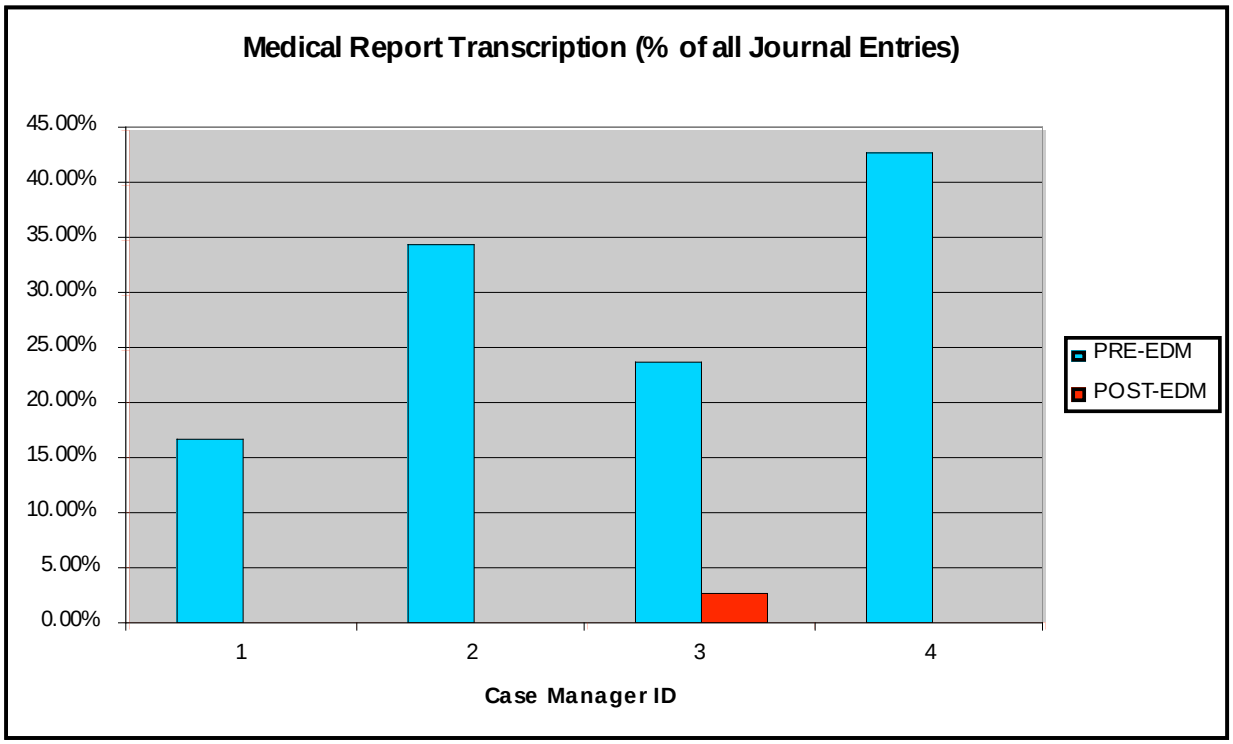

Figure 2b. Pre-EDM vs. Post-EDM Journal Entries (4 Case Manager/Single Customer Pod)

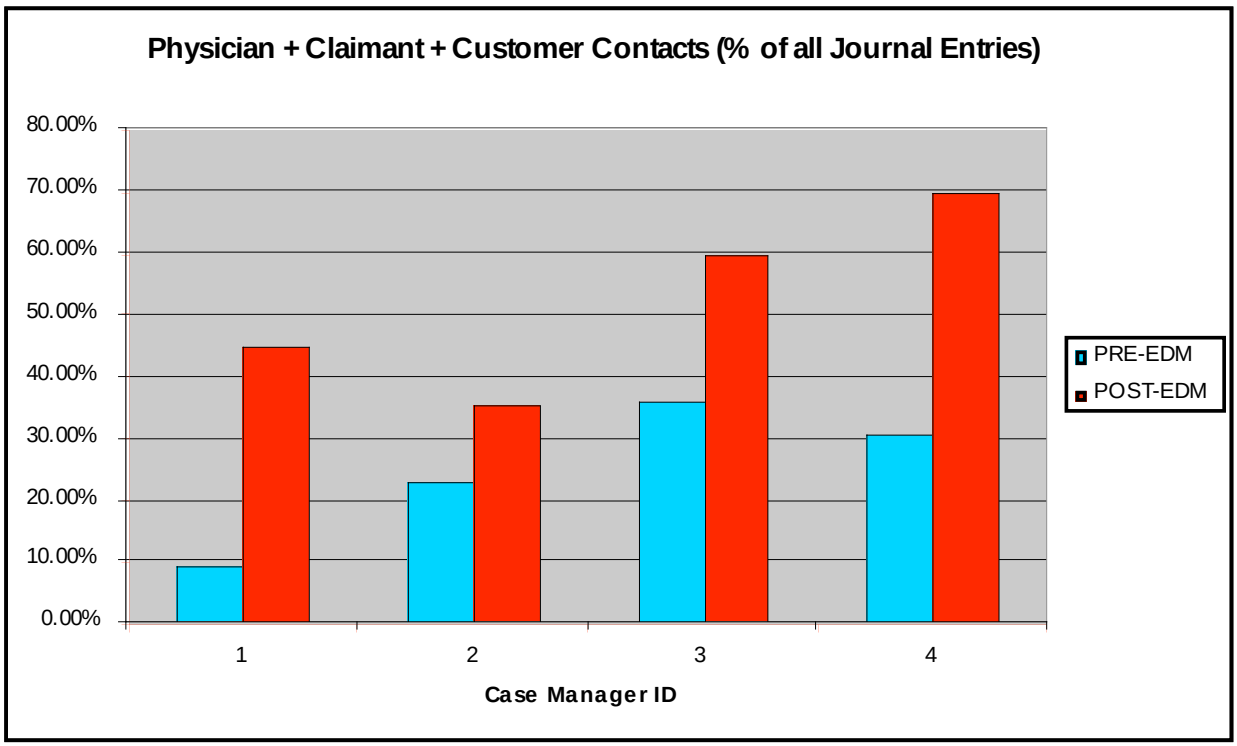

Figure 2c. Pre-EDM vs. Post-EDM Journal Entries (4 Case Manager/Single Customer Pod)

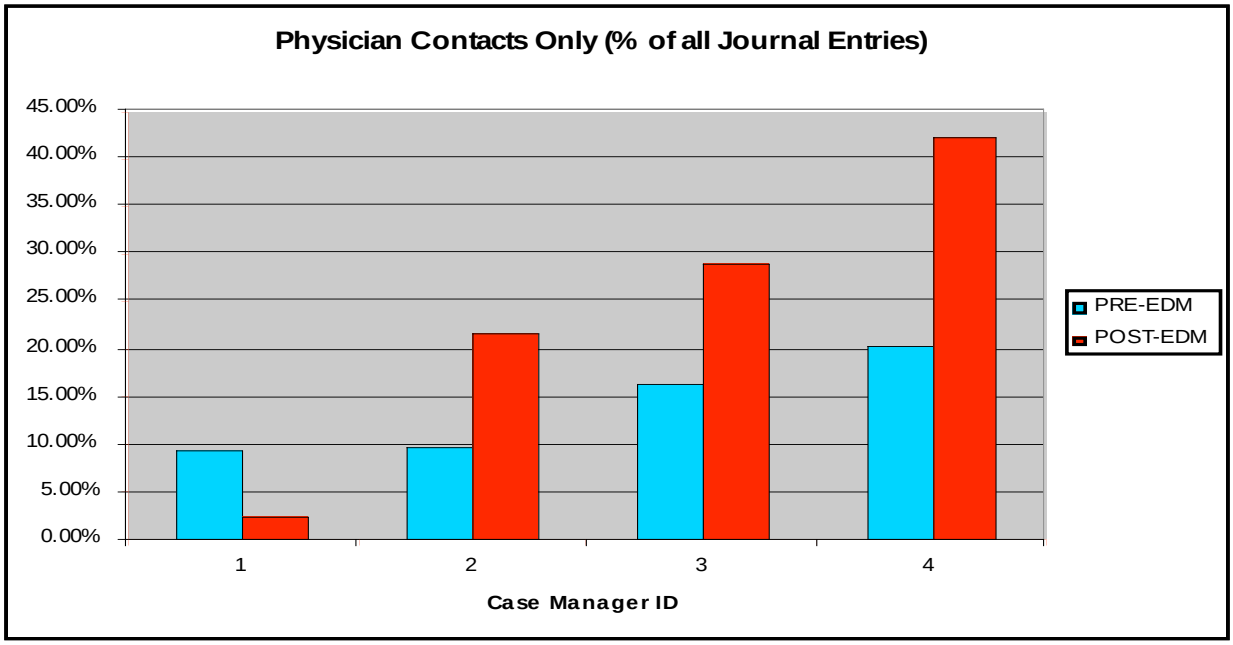

Figure 2d. Pre-EDM vs. Post-EDM Journal Entries (4 Case Manager/Single Customer Pod)

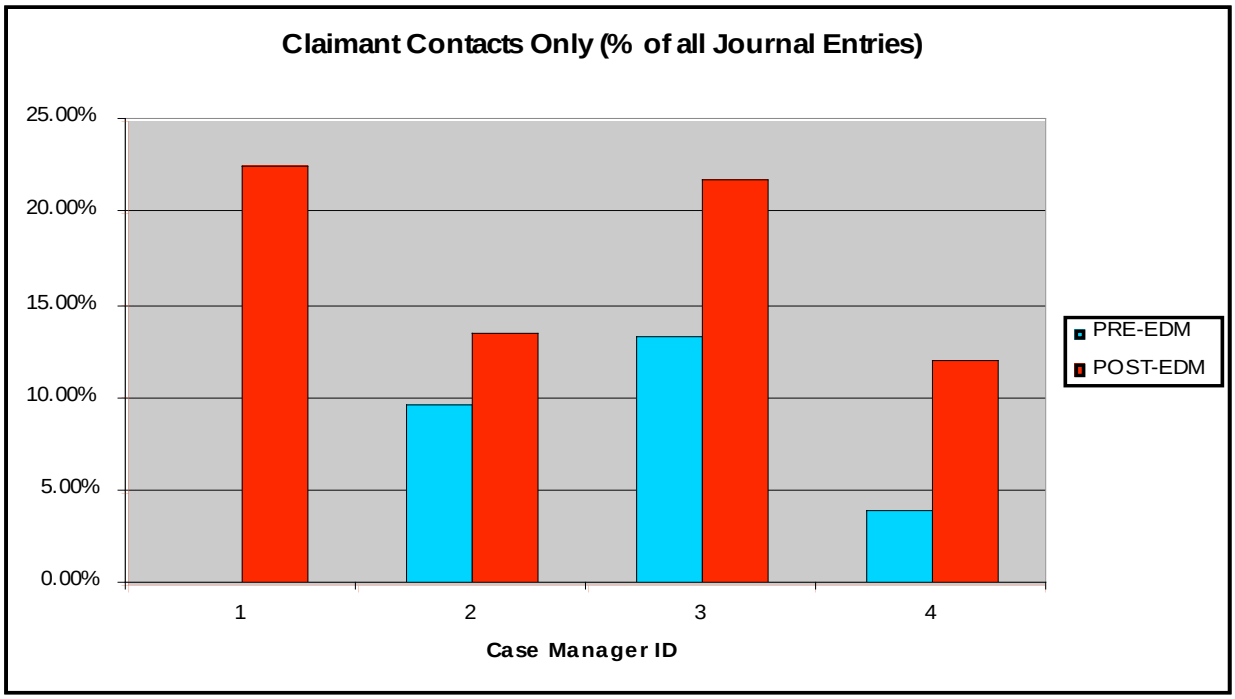

Figure 2e. Pre-EDM vs. Post-EDM Journal Entries (4 Case Manager/Single Customer Pod)

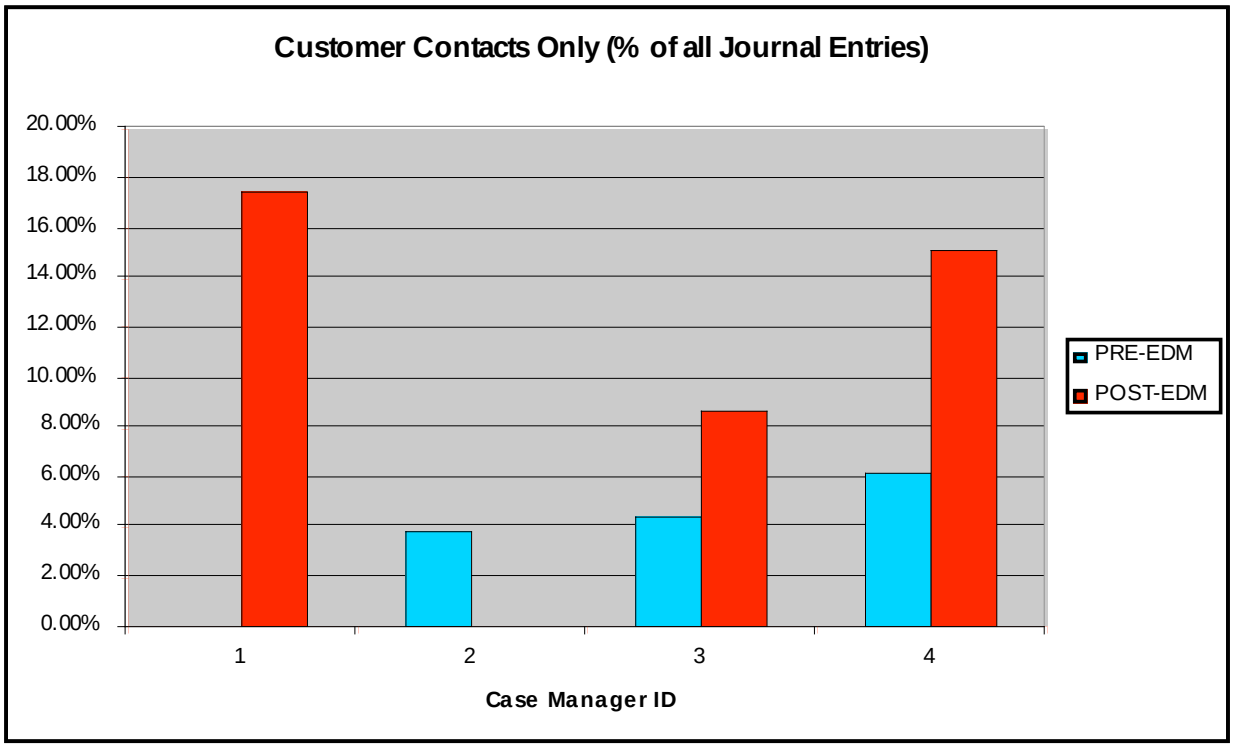

Figure 3. Re-Allocation of Net Time Savings (4 Case Manager/Single Customer Pod)

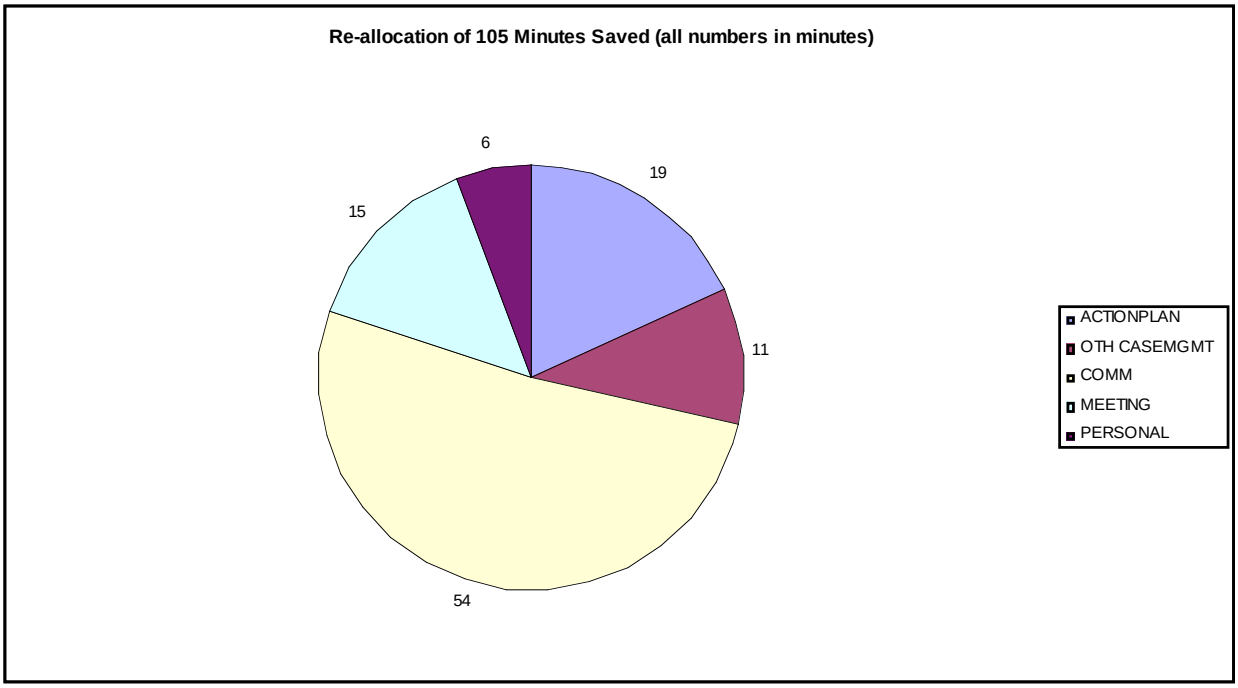

Table 2. Mean Time Use analysis on matched sample N=26 Case Managers

*Note all % are means or arithmetic averages.

								POST-EDM (N=26)		
		PRE-EDM (matched sample) (N=26)						t=1	t=2	
Category	Activity	category	activity	activity%	ACTIVITY GROUP	%	ANALYSIS CAT.	activity%	activity%	avg %
Mail	Sorting Incoming Mail	1	1	1.6	OTH PAPER	7.0	OTH PAPER	0.2	0.3	4.8
Mail	Opening Mail	1	2	0.2	OTH PAPER			0.4	0.1	
Mail	Extracting Mail	1	3	0.0	OTH PAPER			0.3	0.0	
Mail	Identifying Mail	1	4	0.4	OTH PAPER			0.0	0.5	
Mail	Delivering Mail	1	5	0.0	OTH PAPER			0.1	0.1	
Mail	Mailing Outgoing Mail	1	7	0.4	OTH PAPER			0.9	0.5	
Mail	Date-stamping Mail	1	9	0.0	OTH PAPER			0.0	0.0	
Doc	Documenting Paper Mail & Paper Fax	2	1	7.8	DOC PAPER	7.8	DOC PAPER	2.5	1.0	1.8
Doc	Documenting Impact	2	2	0.6	OTH DOC	13.5	OTH DOC	0.3	0.2	9.7
Doc	Documenting Action Plan/Initial Asses	2	3	8.1	ACTIONPLAN	10.9	ACTIONPLAN	8.8	10.6	10.9
Doc	Writing Journal Entries	2	4	11.3	OTH DOC			8.7	6.1	
Doc	Financial Notes	2	5	1.4	OTH CASEMGMT	10.2	OTH CASEMGMT	2.5	1.6	10.7
Comm	Phone	3	1	19.0	COMM	26.4	COMM	23.1	21.8	32.5
Comm	Voicemail	3	2	1.9	COMM			2.1	1.7	
Comm	E-mail	3	3	5.5	COMM			5.7	10.4	
Comm	In-person meeting	3	4	10.9	MEETING	10.9	MEETING	4.3	5.5	5.3
Comm	Sending Paper Fax	3	5	0.5	OTH PAPER			0.4	0.5	
Comm	Sending Right Fax	3	6	0.3	RIGHTFAX	0.4	RIGHTFAX	0.5	0.6	0.7
Comm	Putting Together Paper Items to Mail	3	7	0.4	OTH PAPER			0.2	0.3	
Comm	Manage EDM Inbox (Complete Notific	3	9	0.0	EDM	0.0	EDM	0.9	0.8	7.6
Filework	Accessing Paper File	4	1	0.8	OTH PAPER			0.8	0.1	
Filework	File Sorting/Removing Duplicates	4	2	0.3	OTH PAPER			0.1	0.1	
Filework	Copying Files	4	3	0.5	OTH PAPER			0.0	0.2	
Filework	Electronic Formwork	4	4	0.4	OTH FILEWORK	0.8	OTH FILEWORK	0.2	0.2	0.4
Filework	Paper Formwork	4	5	0.1	OTH PAPER			0.3	0.1	
Filework	Payments	4	6	1.2	OTH CASEMGMT			0.3	1.6	
Filework	Printing from Systems (ExPrs, Beauc	4	7	0.4	OTH PAPER			0.2	0.3	
Filework	Closing File from System	4	8	0.5	OTH FILEWORK			0.2	0.3	
Filework	Accessing EDM File	4	9	0.0	EDM			0.7	0.8	
Filework	Printing EDM File	4	10	0.0	OTH PAPER			0.3	0.1	
Filework	Dragging & Dropping/Uploading/Com	4	11	0.0	EDM			3.8	3.8	
Filework	Complete EDM Document Properties	4	13	0.0	EDM			0.9	0.8	
Filework	Linking Journal Entry to EDM Docum	4	14	0.0	EDM			0.2	0.1	
Filework	Exporting EDM Documents to deskto	4	15	0.0	EDM			0.0	0.2	
Case Manager	Opening New Claim (Fax to Call Cent	5	1	0.4	OTH CASEMGMT			0.2	0.0	
Case Manager	Sending Notice for File Jacket Creatio	5	2	0.1	OTH CASEMGMT			0.0	0.0	
Case Manager	Transfering Files to SDU or CST	5	4	0.1	OTH CASEMGMT			0.9	0.2	
Case Manager	Re-Identifying Files	5	5	0.5	OTH CASEMGMT			0.2	0.0	
Case Manager	RTW Plans	5	6	2.7	ACTIONPLAN			1.5	1.0	
Case Manager	Setting Up Referrals (RMD/Nurses/At	5	7	0.5	OTH CASEMGMT			0.3	0.5	
Case Manager	Medical Management	5	8	1.9	OTH CASEMGMT			4.3	3.4	
Case Manager	Making decision to Accept or Reject F	5	9	1.3	OTH CASEMGMT			1.0	0.4	
Case Manager	Assigning Claims (from TM/SCM to C	5	10	0.1	OTH CASEMGMT			0.0	0.2	
Case Manager	Recording Statements	5	11	2.8	OTH CASEMGMT			1.3	2.2	
Case Manager	Documenting Claim Screen / Details	5	12	1.6	OTH DOC			3.0	1.0	
Case Manager	Reviewing Paper Files	5	13	0.4	OTH PAPER			0.6	0.6	
Case Manager	Reviewing EDM Files	5	14	0.0	EDM			0.8	1.4	
Personal	Break	6	1	0.7	PERSONAL	10.9	PERSONAL	1.9	1.7	13.7
Personal	Lunch	6	2	9.0	PERSONAL			11.9	10.0	
Personal	Personal Phone Call	6	3	0.3	PERSONAL			0.1	0.1	
Personal	Other	6	4	0.9	PERSONAL			0.6	1.1	
Administration	Printing / Stapling Incoming Right Fax	7	1	0.7	OTH PAPER			0.0	0.4	
Administration	Sorting / Identifying Incoming Right Fa	7	2	0.2	RIGHTFAX			0.3	0.0	
Administration	Identifying Incoming Paper Faxes	7	6	0.0	OTH PAPER			0.2	0.0	
Administration	Distributing Incoming Paper Faxes	7	7	0.1	OTH PAPER			0.0	0.0	
Administration	Drop Filing (both picking out and putti	7	8	0.3	OTH PAPER			0.0	0.0	
Administration	Correcting Files (paper)	7	9	0.0	OTH PAPER			0.1	0.0	
Supervision/Ev	Conducting Informal QA of File(s)	8	2	0.0	OTHER			0.1	0.0	
Supervision/Ev	Providing Feedback to CMs	8	3	0.1	MEETING			0.0	0.9	
Other	Other Task	9	1	1.1	OTHER			0.6	3.4	
				100.0				100.0	100.0	

Figure 4a. Pre-EDM vs. Post-EDM Time Use (Office-Wide Study)

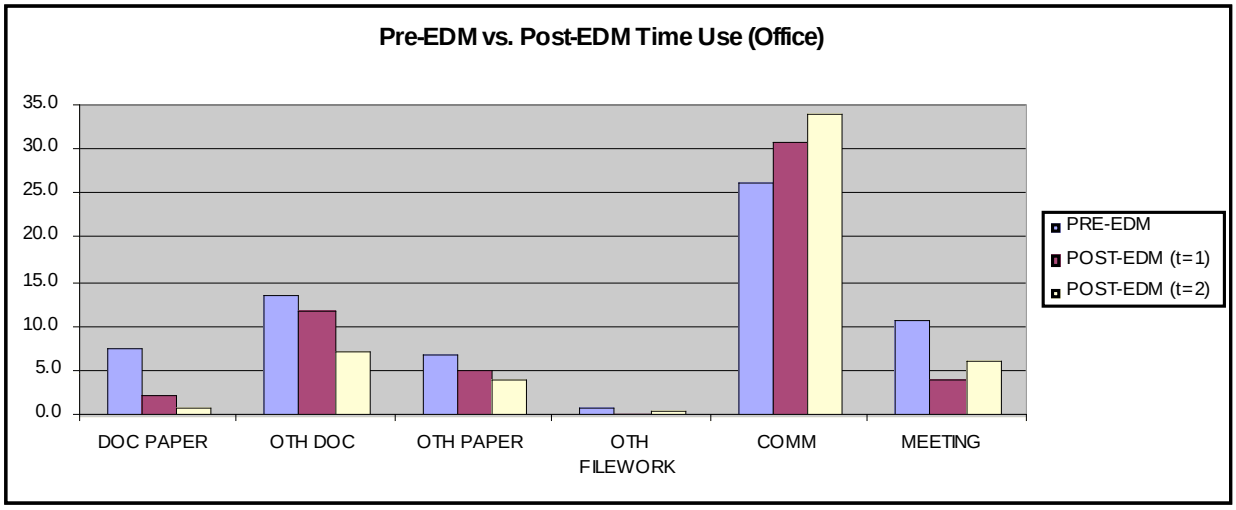

Figure 4b. Pre-EDM vs. Post-EDM Time Use (Office-Wide Study)

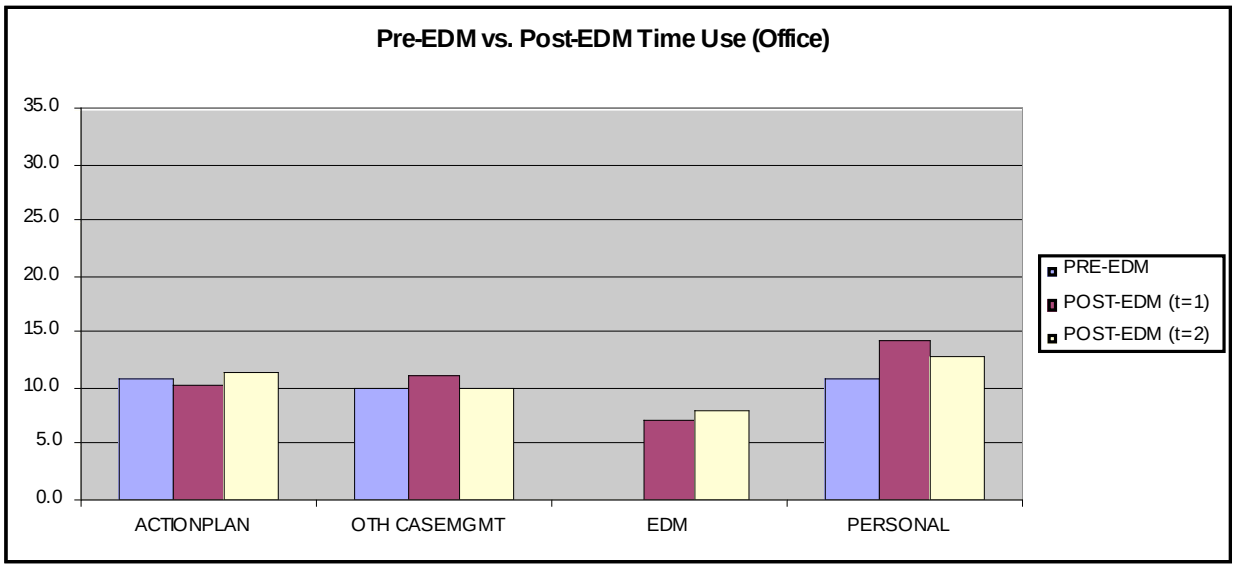

Table 3. Median Time Use analysis on matched sample N=26 Case Managers

*Note all % are medians.

								POST-EDM (N=26)	
		PRE-EDM (matched sample) (N=26)						t=1	
Category	**Activity**	**category**	**activity**	**activity%**	**ACTIVITY GROUP**	**%**	**ANALYSIS CAT.**	**activity%**	**%**
Mail	Sorting Incoming Mail	1	1	0.0	OTH PAPER	**0.0**	**OTH PAPER**	0.0	**0.0**
Mail	Opening Mail	1	2	0.0	OTH PAPER			0.0	
Mail	Extracting Mail	1	3	0.0	OTH PAPER			0.0	
Mail	Identifying Mail	1	4	0.0	OTH PAPER			0.0	
Mail	Delivering Mail	1	5	0.0	OTH PAPER			0.0	
Mail	Mailing Outgoing Mail	1	7	0.0	OTH PAPER			0.0	
Mail	Date-stamping Mail	1	9	0.0	OTH PAPER			0.0	
Doc	Documenting Paper Mail & Paper Fax	2	1	6.0	DOC PAPER	**6.0**	**DOC PAPER**	0.0	**0.0**
Doc	Documenting Impact	2	2	0.0	OTH DOC	**8.6**	**OTH DOC**	0.0	**4.1**
Doc	Documenting Action Plan/Initial Asses	2	3	4.1	ACTIONPLAN	**4.1**	**ACTIONPLAN**	5.1	**5.1**
Doc	Writing Journal Entries	2	4	8.6	OTH DOC			4.1	
Doc	Financial Notes	2	5	0.9	OTH CASEMGMT	**0.9**	**OTH CASEMGMT**	0.0	**1.0**
Comm	Phone	3	1	18.8	COMM	**23.7**	**COMM**	23.1	**30.6**
Comm	Voicemail	3	2	2.0	COMM			2.0	
Comm	E-mail	3	3	2.9	COMM			5.4	
Comm	In-person meeting	3	4	10.3	MEETING	**10.3**	**MEETING**	2.2	**2.2**
Comm	Sending Paper Fax	3	5	0.0	OTH PAPER			0.0	
Comm	Sending Right Fax	3	6	0.0	RIGHTFAX	**0.0**	**RIGHTFAX**	0.0	**0.0**
Comm	Putting Together Paper Items to Mail	3	7	0.0	OTH PAPER			0.0	
Comm	Manage EDM Inbox (Complete Notific	3	9	0.0	EDM	**0.0**	**EDM**	0.0	**1.0**
Filework	Accessing Paper File	4	1	0.0	OTH PAPER			0.0	
Filework	File Sorting/Removing Duplicates	4	2	0.0	OTH PAPER			0.0	
Filework	Copying Files	4	3	0.0	OTH PAPER			0.0	
Filework	Electronic Formwork	4	4	0.0	OTH FILEWORK	**0.0**	**OTH FILEWORK**	0.0	**0.0**
Filework	Paper Formwork	4	5	0.0	OTH PAPER			0.0	
Filework	Payments	4	6	0.0	OTH CASEMGMT			0.0	
Filework	Printing from Systems (ExPrs, Beauc	4	7	0.0	OTH PAPER			0.0	
Filework	Closing File from System	4	8	0.0	OTH FILEWORK			0.0	
Filework	Accessing EDM File	4	9	0.0	EDM			0.0	
Filework	Printing EDM File	4	10	0.0	OTH PAPER			0.0	
Filework	Dragging & Dropping/Uploading/Com	4	11	0.0	EDM			1.0	
Filework	Complete EDM Document Properties	4	13	0.0	EDM			0.0	
Filework	Linking Journal Entry to EDM Docume	4	14	0.0	EDM			0.0	
Filework	Exporting EDM Documents to desktop	4	15	0.0	EDM			0.0	
Case Manager	Opening New Claim (Fax to Call Cent	5	1	0.0	OTH CASEMGMT			0.0	
Case Manager	Sending Notice for File Jacket Creatic	5	2	0.0	OTH CASEMGMT			0.0	
Case Manager	Transfering Files to SDU or CST	5	4	0.0	OTH CASEMGMT			0.0	
Case Manager	Re-Identifying Files	5	5	0.0	OTH CASEMGMT			0.0	
Case Manager	RTW Plans	5	6	0.0	ACTIONPLAN			0.0	
Case Manager	Setting Up Referrals (RMD/Nurses/At	5	7	0.0	OTH CASEMGMT			0.0	
Case Manager	Medical Management	5	8	0.0	OTH CASEMGMT			1.0	
Case Manager	Making decision to Accept or Reject F	5	9	0.0	OTH CASEMGMT			0.0	
Case Manager	Assigning Claims (from TM/SCM to C	5	10	0.0	OTH CASEMGMT			0.0	
Case Manager	Recording Statements	5	11	0.0	OTH CASEMGMT			0.0	
Case Manager	Documenting Claim Screen / Details	5	12	0.0	OTH DOC			0.0	
Case Manager	Reviewing Paper Files	5	13	0.0	OTH PAPER			0.0	
Case Manager	Reviewing EDM Files	5	14	0.0	EDM			0.0	
Personal	Break	6	1	0.0	PERSONAL	**9.7**	**PERSONAL**	1.8	**14.0**
Personal	Lunch	6	2	9.7	PERSONAL			12.1	
Personal	Personal Phone Call	6	3	0.0	PERSONAL			0.0	
Personal	Other	6	4	0.0	PERSONAL			0.0	
Administration	Printing / Stapling Incoming Right Fax	7	1	0.0	OTH PAPER			0.0	
Administration	Sorting / Identifying Incoming Right Fa	7	2	0.0	RIGHTFAX			0.0	
Administration	Identifying Incoming Paper Faxes	7	6	0.0	OTH PAPER			0.0	
Administration	Distributing Incoming Paper Faxes	7	7	0.0	OTH PAPER			0.0	
Administration	Drop Filing (both picking out and putti	7	8	0.0	OTH PAPER			0.0	
Administration	Correcting Files (paper)	7	9	0.0	OTH PAPER			0.0	
Supervision/Ev	Conducting Informal QA of File(s)	8	2	0.0	OTHER			0.0	
Supervision/Ev	Providing Feedback to CMs	8	3	0.0	MEETING			0.0	
Other	Other Task	9	1	0.0	OTHER			0.0	
				63.4				57.9	

Figure 5. Re-Allocation of Net Time Savings (Office-Wide Time Use Study)

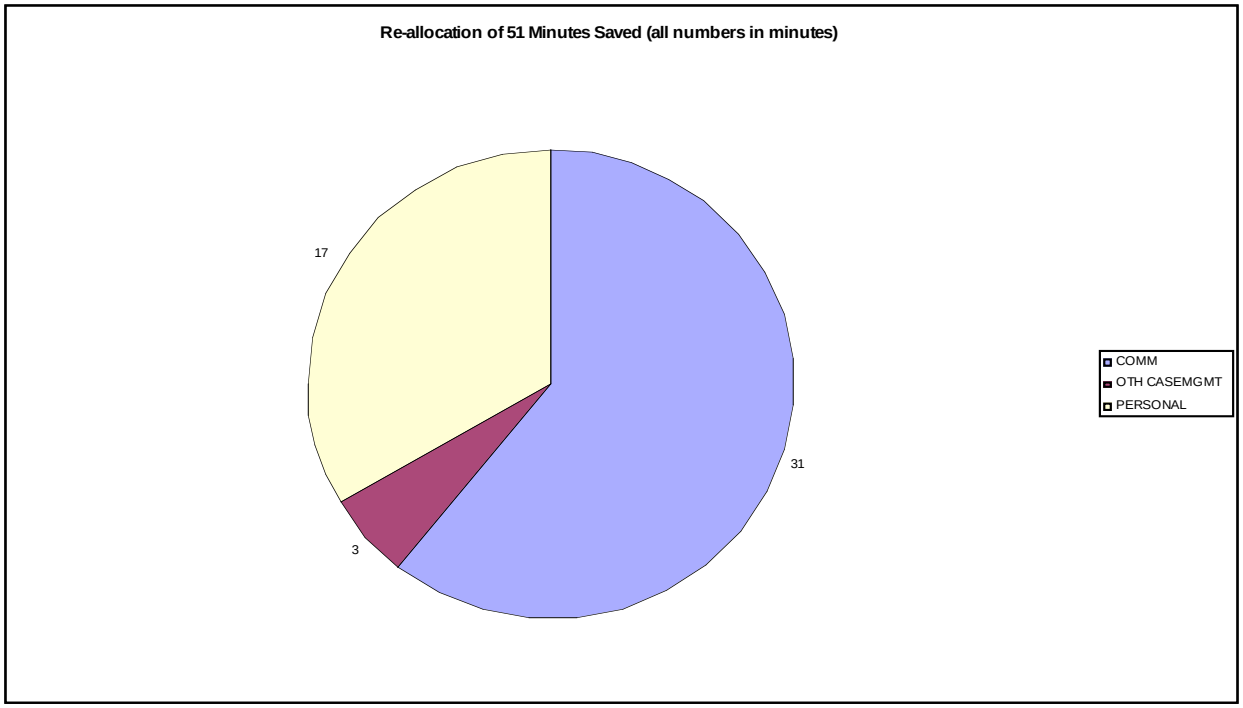

Figure 6a. Activity Counts Analysis (Documentation Category)

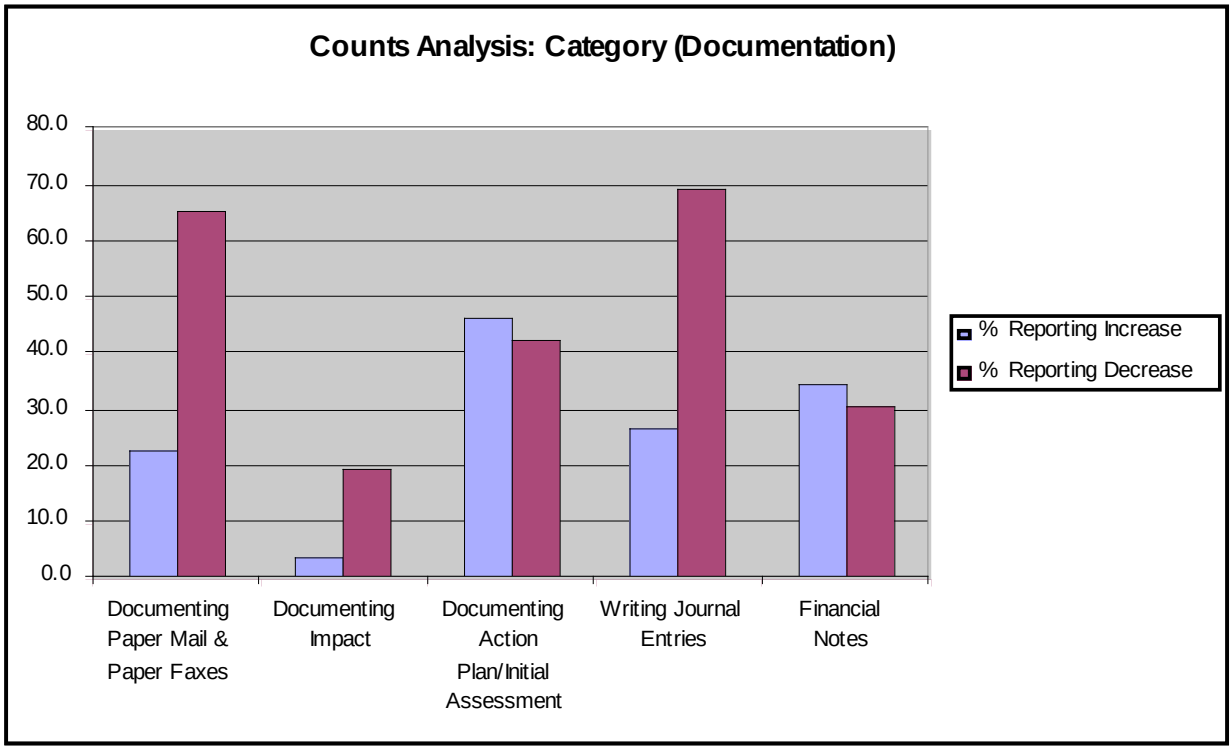

Figure 6b. Activity Counts Analysis (Communication Category)

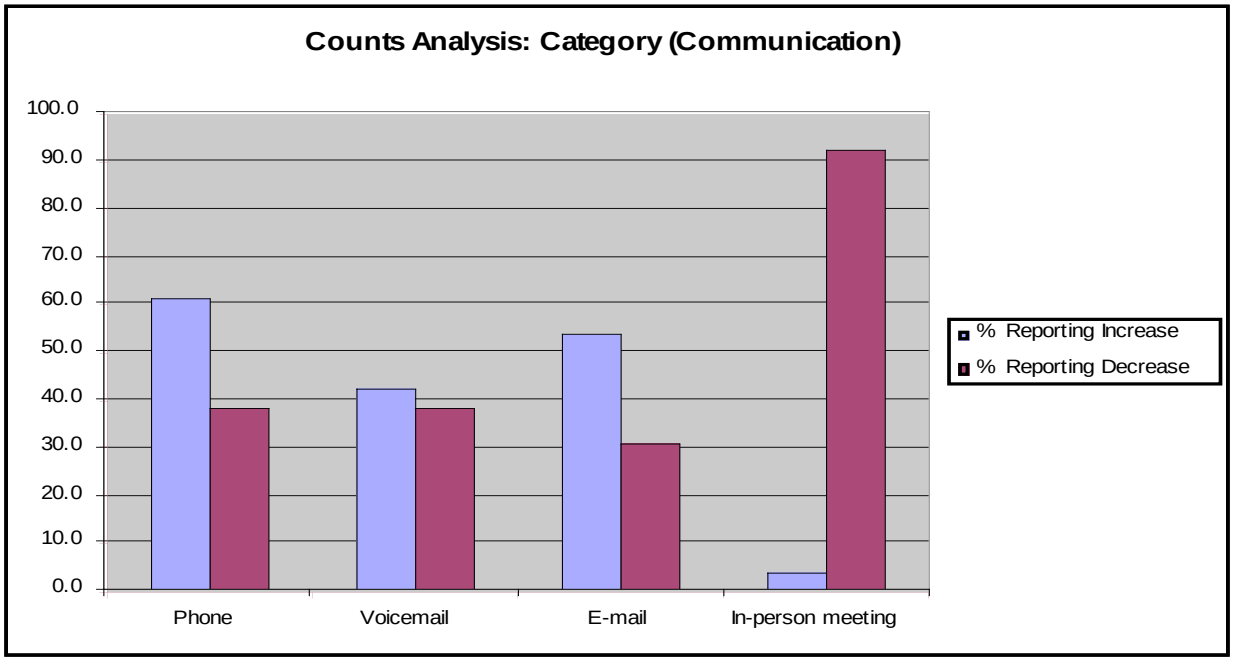

Figure 6c. Activity Counts Analysis (Personal Category)

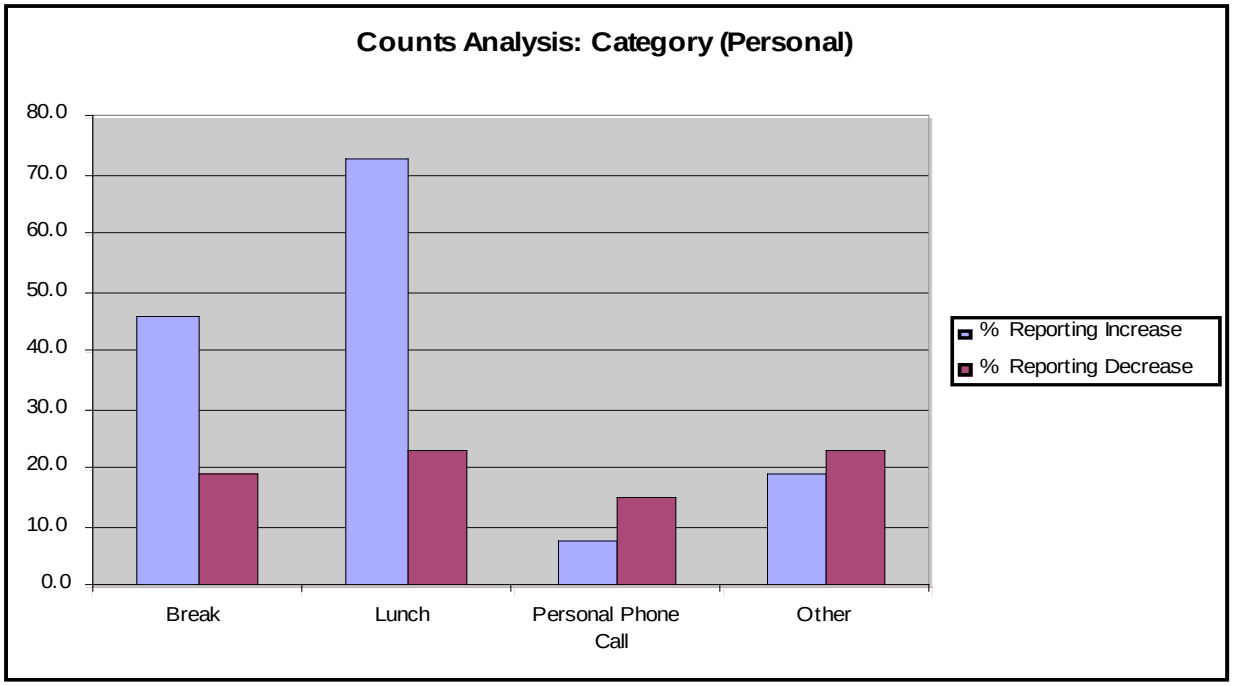

Figure 6d. Activity Counts Analysis (Based on Activity Groups)

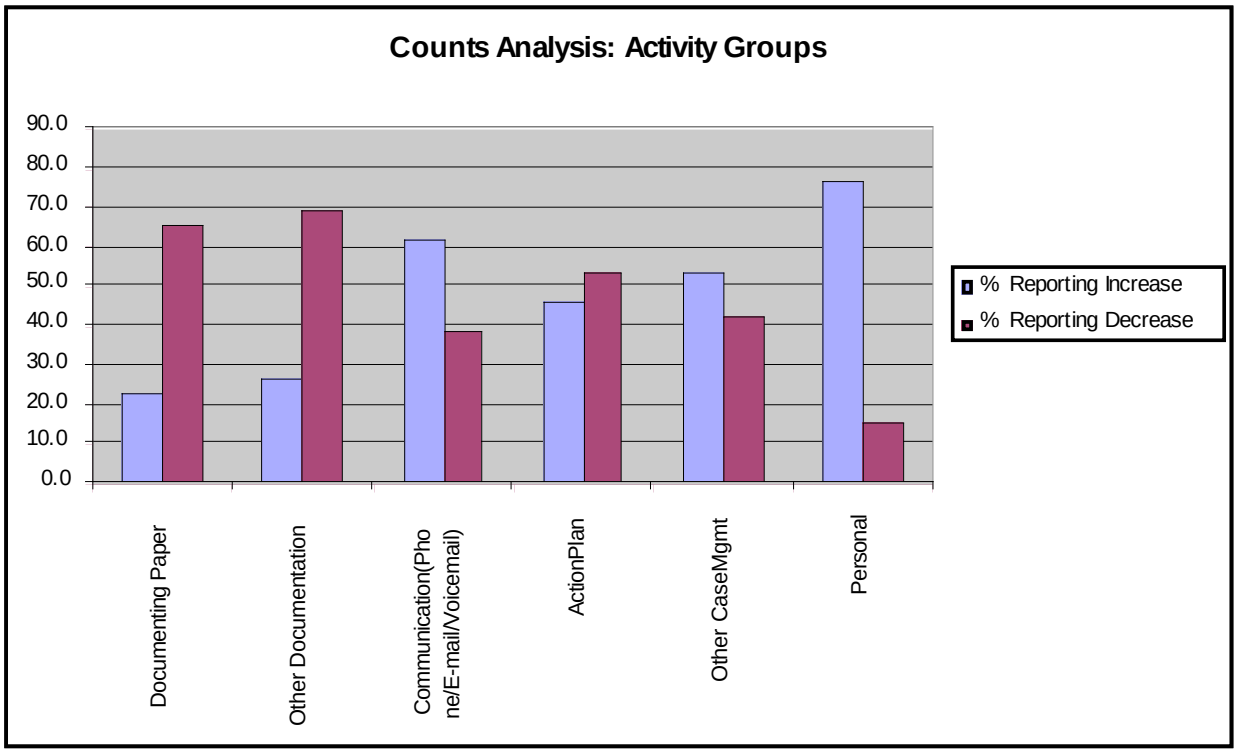

Table 7. Mean Time Use analysis on full sample PRE-EDM N=53, POST-EDM (t=1) N=46, (t=2) N=56
*Note all % are means or arithmetic averages.

		PRE-EDM (full sample) (N=53)						POST-EDM (t=1) (N=46)		(t=2) (N=56)
Category	Activity	category	activity	activity%	ACTIVITY GROUP	%	ANALYSIS CAT.	activity%	activity%	AVG
Mail	Sorting Incoming Mail	1	1	1.4	OTH PAPER	6.2	OTH PAPER	0.4	0.5	4.6
Mail	Opening Mail	1	2	0.3	OTH PAPER			0.3	0.3	
Mail	Extracting Mail	1	3	0.0	OTH PAPER			0.2	0.0	
Mail	Identifying Mail	1	4	0.4	OTH PAPER			0.0	0.4	
Mail	Delivering Mail	1	5	0.0	OTH PAPER			0.1	0.1	
Mail	Mailing Outgoing Mail	1	7	0.2	OTH PAPER			0.5	0.5	
Mail	Date-stamping Mail	1	9	0.1	OTH PAPER			0.0	0.3	
Doc	Documenting Paper Mail & Pape	2	1	7.3	DOC PAPER	7.3	DOC PAPER	2.8	1.1	2.0
Doc	Documenting Impact	2	2	0.3	OTH DOC	14.5	OTH DOC	0.7	0.3	8.9
Doc	Documenting Action Plan/Initial A	2	3	8.2	ACTIONPLAN	9.7	ACTIONPLAN	10.6	11.0	12.9
Doc	Writing Journal Entries	2	4	10.5	OTH DOC			6.9	4.6	
Doc	Financial Notes	2	5	2.8	OTH CASEMGMT	11.7	OTH CASEMGMT	2.4	2.0	10.9
Comm	Phone	3	1	20.5	COMM	27.5	COMM	19.4	22.1	30.7
Comm	Voicemail	3	2	2.3	COMM			3.7	2.9	
Comm	E-mail	3	3	4.6	COMM			5.9	7.4	
Comm	In-person meeting	3	4	9.4	MEETING	9.5	MEETING	4.1	3.9	4.2
Comm	Sending Paper Fax	3	5	0.6	OTH PAPER			0.3	0.4	
Comm	Sending Right Fax	3	6	0.2	RIGHTFAX	0.3	RIGHTFAX	0.8	0.9	1.2
Comm	Putting Together Paper Items to	3	7	0.5	OTH PAPER			0.2	0.3	
Comm	Manage EDM Inbox (Complete N	3	9	0.0	EDM	0.0	EDM	1.0	1.2	8.3
Filework	Accessing Paper File	4	1	0.5	OTH PAPER			0.5	0.1	
Filework	File Sorting/Removing Duplicates	4	2	0.1	OTH PAPER			0.3	0.1	
Filework	Copying Files	4	3	0.3	OTH PAPER			0.1	0.3	
Filework	Electronic Formwork	4	4	0.2	OTH FILEWORK	1.2	OTH FILEWORK	0.1	0.3	0.6
Filework	Paper Formwork	4	5	0.1	OTH PAPER			0.3	0.1	
Filework	Payments	4	6	1.7	OTH CASEMGMT			0.3	1.9	
Filework	Printing from Systems (ExPrs, B	4	7	0.2	OTH PAPER			0.2	0.2	
Filework	Closing File from System	4	8	1.0	OTH FILEWORK			0.2	0.5	
Filework	Accessing EDM File	4	9	0.0	EDM			0.9	0.8	
Filework	Printing EDM File	4	10	0.0	OTH PAPER			0.2	0.1	
Filework	Dragging & Dropping/Uploading/	4	11	0.0	EDM			3.7	4.4	
Filework	Complete EDM Document Prope	4	13	0.0	EDM			1.2	0.4	
Filework	Linking Journal Entry to EDM Do	4	14	0.0	EDM			0.1	0.2	
Filework	Exporting EDM Documents to de	4	15	0.0	EDM			0.0	0.1	
Case Manage	Opening New Claim (Fax to Call	5	1	0.3	OTH CASEMGMT			0.4	0.0	
Case Manage	Sending Notice for File Jacket C	5	2	0.0	OTH CASEMGMT			0.0	0.0	
Case Manage	Transfering Files to SDU or CST	5	4	0.2	OTH CASEMGMT			0.8	0.3	
Case Manage	Re-Identifying Files	5	5	0.3	OTH CASEMGMT			0.1	0.1	
Case Manage	RTW Plans	5	6	1.5	ACTIONPLAN			2.5	1.8	
Case Manage	Setting Up Referrals (RMD/Nurs	5	7	1.7	OTH CASEMGMT			0.5	1.1	
Case Manage	Medical Management	5	8	1.8	OTH CASEMGMT			3.7	2.6	
Case Manage	Making decision to Accept or Re	5	9	0.8	OTH CASEMGMT			0.6	0.2	
Case Manage	Assigning Claims (from TM/SCM	5	10	0.1	OTH CASEMGMT			0.0	0.1	
Case Manage	Recording Statements	5	11	2.1	OTH CASEMGMT			2.0	2.8	
Case Manage	Documenting Claim Screen / De	5	12	3.7	OTH DOC			3.3	1.9	
Case Manage	Reviewing Paper Files	5	13	0.4	OTH PAPER			0.4	0.7	
Case Manage	Reviewing EDM Files	5	14	0.0	EDM			0.9	1.7	
Personal	Break	6	1	0.9	PERSONAL	10.7	PERSONAL	1.8	1.9	14.1
Personal	Lunch	6	2	8.6	PERSONAL			11.7	10.4	
Personal	Personal Phone Call	6	3	0.3	PERSONAL			0.3	0.2	
Personal	Other	6	4	0.9	PERSONAL			0.6	1.2	
Administration	Printing / Stapling Incoming Righ	7	1	0.7	OTH PAPER			0.0	0.3	
Administration	Sorting / Identifying Incoming Rig	7	2	0.1	RIGHTFAX			0.3	0.3	
Administration	Identifying Incoming Paper Faxes	7	6	0.1	OTH PAPER			0.4	0.0	
Administration	Distributing Incoming Paper Faxe	7	7	0.1	OTH PAPER			0.1	0.0	
Administration	Drop Filing (both picking out and	7	8	0.2	OTH PAPER			0.0	0.1	
Administration	Correcting Files (paper)	7	9	0.0	OTH PAPER			0.0	0.0	
Supervision/E	Conducting Informal QA of File(s	8	2	0.1	OTHER			0.0	0.0	
Supervision/E	Providing Feedback to CMs	8	3	0.0	MEETING			0.0	0.4	
Other	Other Task	9	1	1.2	OTHER			0.9	1.9	

Table 4a. Differences-In-Differences Fixed Effects Pooled Regressions

Independent Var.	Dependent Var.: Current Yr. Closure Rate (TREATMENT LAG=1) OLS (N=192)	Beat Current Yr. Closure Rate Goal (TREATMENT LAG=1) LOGIT (N=192)	Previous Yr. Closure Rate (TREATMENT LAG=1) OLS (N=184)
EDM TREAT	**0.005 (0.008)**	**1.778 (0.738) ****	**-0.006 (0.007)**
TOT. STAFF	**0.001 (0.0007)**	**0.152 (0.090) ***	**0.0004(0.001)**
INC. CLAIM	**-2.71e-06 (0.000014)**	**0.001 (0.001)**	**-1.19e-05 (0.00002)**
FEB	**0.331*** (0.014)**	**-2.397 (0.941)****	**0.037** (0.0167)**
MAR	**0.460*** (0.012)**	**-2.510 (0.928)****	**0.080*** (0.0155)**
APR	**0.517*** (0.012)**	**-1.202 (0.964)**	**0.113*** (0.015)**
MAY	**0.555*** (0.011)**	**-0.935 (0.989)**	**0.149*** (0.015)**
JUN	**0.581*** (0.011)**	**-1.055 (0.996)**	**0.183*** (0.015)**
JUL	**0.603*** (0.0122)**	**-0.937 (1.043)**	**0.210*** (0.016)**
AUG	**0.622*** (0.011)**	**-2.812** (1.005)**	**0.244*** (0.016)**
SEP	**0.641*** (0.012)**	**-2.047* (1.049)**	**0.269*** (0.016)**
OCT	**0.658*** (0.012)**	**-1.631 (1.049)**	**0.292*** (0.016)**
NOV	**0.673*** (0.012)**	**-1.054 (1.122)**	**0.317*** (0.018)**
DEC	**0.685*** (0.012)**	**-0.398 (1.103)**	**0.348*** (0.018)**
YEAR	**0.013*** (0.011)**	**1.917** (0.840)**	**0.008*** (0.010)**
R^2	**0.999**	**LOGIT (not relevant)**	**0.993**
F-stat (p-value)	**24031 (0.0)**	**LOGIT (not relevant)**	**1903.59 (0.0)**

Heteroskedasticity-robust Huber/White standard errors are reported in parentheses for OLS regressions. For logistic regression standard errors are reported in parentheses.

Note: coefficients for office dummies not shown for sake of privacy

***** indicates significance at the 1% level**
**** indicates significance at the 5% level**
*** indicates significance at the 10% level**

Table 4b. Differences-In-Differences Fixed Effects Pooled Regressions

Independent Var.	Dependent Var. Avg. Physical Therapy Paid (TREATMENT LAG=3)	Avg. Chiropractor Care Paid (TREATMENT LAG=2)	Staff Retention Rate (TREATMENT LAG=1)
	OLS (N=176)	OLS (N=176)	OLS (N=168)
EDM TREAT	**-111.175*** (20.116)**	**-154.59*** (23.674)**	**0.054*** (0.020)**
TOT. STAFF	**-7.856*** (2.038)**	**-2.87 (2.047)**	
FEB	**121.196*** (35.969)**	**110.439*** (34.717)**	**0.058 (0.040)**
MAR	**158.928*** (36.765)**	**177.27*** (35.037)**	**0.042* (0.022)**
APR	**215.312*** (37.164)**	**272.276*** (39.970)**	**0.007 (0.015)**
MAY	**216.254*** (36.177)**	**291.177*** (37.878)**	**0.008 (0.014)**
JUN	**239.921*** (38.322)**	**303.909*** (37.773)**	**-0.004 (0.012)**
JUL	**250.334*** (42.072)**	**312.658*** (40.683)**	**-0.008 (0.013)**
AUG	**263.871*** (42.738)**	**335.501*** (42.947)**	**-0.005 (0.014)**
SEP	**208.256*** (39.057)**	**275.933*** (39.169)**	**0.004 (0.013)**
OCT	**173.479*** (37.886)**	**241.965*** (38.526)**	**0.007 (0.014)**
NOV	**136.052*** (38.406)**	**212.260*** (39.578)**	**-0.001 (0.013)**
DEC	**121.543*** (38.701)**	**204.914*** (40.158)**	
YEAR	**-107.531*** (23.366)**	**-40.806 (26.332)**	**-0.040** (0.019)**
R^2	**0.990**	**0.9885**	**0.996**
F-stat (p-value)	**976.56 (0.0)**	**996.67 (0.0)**	**4055.89 (0.0)**

Heteroskedasticity-robust Huber/White standard errors are reported in parentheses for OLS regressions.

Note: coefficients for office dummies not shown for sake of privacy

***** indicates significance at the 1% level**
**** indicates significance at the 5% level**
*** indicates significance at the 10% level**

Table 4c. Differences-In-Differences Fixed Effects Pooled Regressions

Independent Var.	Dependent Var. Loss Leakage (TREATMENT LAG=4) OLS (N=176)	Temporary Total Disability (TTD) (TREATMENT LAG=4) OLS (N=192)
EDM TREAT	**-0.001 (0.0009)**	**0.687** (0.275)**
TOT. STAFF		**0.037 (0.040)**
FEB	**0.0002 (0.0007)**	**0.238 (0.336)**
MAR	**-0.0004 (0.0009)**	**0.739** (0.358)**
APR	**-0.0005 (0.0009)**	**0.830** (0.413)**
MAY	**0.0005 (0.0011)**	**1.273*** (0.421)**
JUN	**0.0001 (0.0010)**	**1.321*** (0.386)**
JUL	**0.0007 (0.0011)**	**1.017*** (0.376)**
AUG	**0.0004 (0.0012)**	**1.159*** (0.409)**
SEP	**0.0008 (0.0012)**	**1.051** (0.417)**
OCT	**0.0016 (0.0012)**	**0.610 (0.452)**
NOV	**0.0005 (0.0012)**	**0.791 (0.484)**
DEC	**0.0005 (0.0012)**	**0.682 (0.447)**
YEAR	**0.0014* (0.0007)**	**0.715** (0.309)**
R^2	**0.990**	**0.999**
F-stat (p-value)	**1430.12 (0.0)**	**10784.65 (0.0)**

Heteroskedasticity-robust Huber/White standard errors are reported in parentheses for OLS regressions.

Note: coefficients for office dummies not shown for sake of privacy

***** indicates significance at the 1% level**
**** indicates significance at the 5% level**
*** indicates significance at the 10% level**

Table 5a. Differences-In-Differences Fixed Effects Pooled Regressions

Independent Var.	Dependent Var. Next-Day Air Courier Costs (TREATMENT LAG=1) OLS (N=192)	Outside Services Fees (TREATMENT LAG=4) OLS (N=120)	Mailing Services Costs (TREATMENT LAG=5) OLS (N=192)
EDM TREAT	**2875.437*** (477.546)**	**-20174*** (4070)**	**-2552*** (748)**
FEB	**392.375 (415.614)**	**566 (1450)**	**26 (660)**
MAR	**900.882** (432.653)**	**656 (1483)**	**-550 (1753)**
APR	**-195.261 (438.989)**	**1197 (1548)**	**-613 (683)**
MAY	**703.336 (492.153)**	**1544 (1490)**	**-547 (682)**
JUN	**2062.371** (806.583)**	**-14917** (6850)**	**-433 (714)**
JUL	**-1858.691** (777.315)**	**20168*** (6267)**	**42 (739)**
AUG	**2001.746*** (693.941)**	**943 (3706)**	**245 (722)**
SEP	**421.371 (485.223)**	**1506 (2751)**	**110 (743)**
OCT	**1840.871** (757.082)**	**387 (3456)**	**142 (802)**
NOV	**-198.656 (460.183)**	**178 (3137)**	**15 (773)**
DEC	**1138.96** (547.182)**	**-435 (3846)**	**-165 (788)**
YEAR	**-120.859 (343.570)**	**-138 (2706)**	**-457 (568)**
R^2	**0.8176**	**0.9683**	**0.9808**
F-stat (p-value)	**48.76 (0.0)**	**1008.12 (0.0)**	**2158.12 (0.0)**

Heteroskedasticity-robust Huber/White standard errors are reported in parentheses for OLS regressions.

Note: coefficients for office dummies not shown for sake of privacy

***** indicates significance at the 1% level**
**** indicates significance at the 5% level**
*** indicates significance at the 10% level**

Table 5b. Differences-In-Differences Fixed Effects Pooled Regressions

Independent Var.	Dependent Var. Off-site Records Storage Costs (TREATMENT LAG=4) OLS (N=168)	Incoming 800 Calls Costs (TREATMENT LAG=0) OLS (N=192)	Telephone Usage Costs (TREATMENT LAG=1) OLS (N=192)
EDM TREAT	**-849*** (316)**	**-151 (132)**	**871 (584)**
FEB	**-337 (452)**	**-189* (105)**	**-123 (557)**
MAR	**-387 (461)**	**151 (141)**	**795 (630)**
APR	**127 (509)**	**-51 (117)**	**14 (501)**
MAY	**16 (492)**	**270* (137)**	**-17 (520)**
JUN	**54 (445)**	**-229* (120)**	**-178 (422)**
JUL	**530 (416)**	**-125 (113)**	**235 (506)**
AUG	**284 (430)**	**-269* (146)**	**-142 (457)**
SEP	**166 (469)**	**-680*** (233)**	**-961** (471)**
OCT	**439 (487)**	**-323 (248)**	**-16 (699)**
NOV	**13 (448)**	**-1307*** (318)**	**-1854*** (701)**
DEC	**-148 (427)**	**-176 (124)**	**-614 (616)**
YEAR	**936*** (281)**	**-89 (119)**	**-156 (523)**
R^2	**0.86**	**0.97**	**0.93**
F-stat (p-value)	**49.46 (0.0)**	**778.17 (0.0)**	**400.40 (0.0)**

Heteroskedasticity-robust Huber/White standard errors are reported in parentheses for OLS regressions.

Note: coefficients for office dummies not shown for sake of privacy

***** indicates significance at the 1% level**
**** indicates significance at the 5% level**
*** indicates significance at the 10% level**

Table 6a. Comparison of EDM TREAT coefficient in Fixed Effects vs. Random Effects Regressions

Dependent Var.	Fixed Effects Model	Random Effects Model	Hausman statistic (p-value)
Current Yr. Closure Rate	**0.005**	0.004	2.41 (0.99)
Previous Yr. Closure Rate	-0.006	**-0.008**	25.31 (0.04)
Avg. Physical Therapy Paid	**-111.175**	-111.132	0.98 (1)
Avg. Chiropractor Care Paid	**-154.590**	-154.647	0.61 (1)
Staff Retention Rate	**0.0545**	0.0548	0.02 (1)
Loss Leakage	**-0.00127**	-0.00128	0.02 (1)
Temp. Tot. Disability. (TTD)	**0.6877**	0.6718	4.72 (0.9894)

Note: All regressions contained the controls shown in tables 4a-4c, office dummies, month dummies, year dummy.

The selected fixed effects or random effects coefficient is highlighted in bold.

Table 6b. Comparison of EDM TREAT coefficient in Fixed Effects vs. Random Effects Regressions

Dependent Var.	Fixed Effects Model	Random Effects Model	Hausman statistic (p-value)
Next-Day Air Courier Costs	**2875**	2839	0.71 (1)
Outside Services Fees	-20174	**-25387**	Negative
Mailing Services Costs	-2552	**-2576**	Negative
Off-site Records Storage Costs	-849	**-933**	Negative
Incoming 800 Calls Costs	**-151**	-154	0.09 (1)
Telephone Usage Costs	871	**797**	Negative

Note: All regressions contained the controls shown in tables 4a-4c, office dummies, month dummies, year dummy.

The selected fixed effects or random effects coefficient is highlighted in bold.

The negative hausman statistic arises because of the finite sample, in which the asymptotic assumptions of the test are not met. In such cases, we pick the fixed effects coefficient, which we know to be consistent.

Figure 7. Pre-EDM vs. Post-EDM Distribution of Backlogged Documents at Work Desk

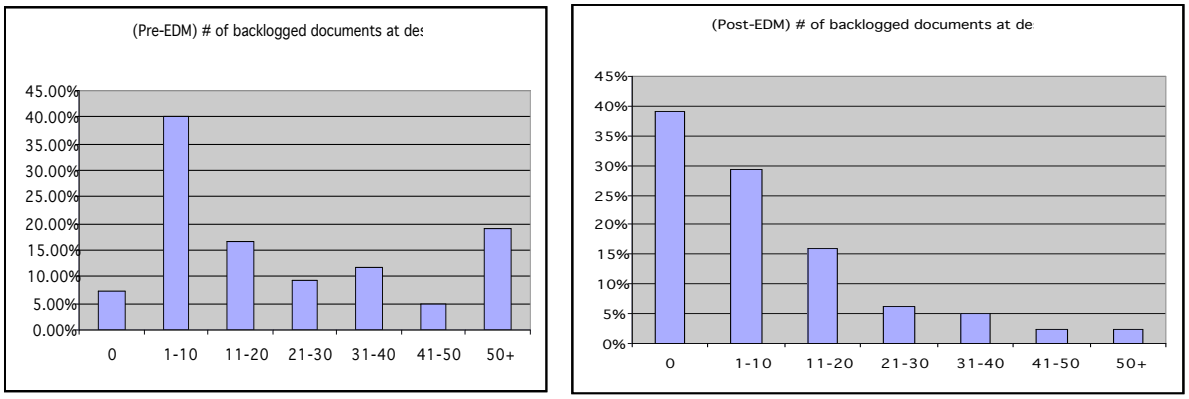

Figure 8. Task Model (Autor et al, 2003)

Routine Manual	Routine Analytic
Ex. Sorting and repetitive assembly	**Ex. Calculations and record-keeping**
Non-routine Manual	Non-routine Analytic
Ex. Driving a vehicle, mopping, cleaning	**Ex. Problem solving and complex communications**

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