Journal for Quality Perspectives in Knowledge Acquisition

This study unmasks those insights that are often hidden or concealed in the data captured by information technology systems. The mechanism of flow analysis converts captured data into critical insights regarding the dynamic movement of work through a process.

Transforming Data Into Insights Using Flow Analysis

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Abstract

The theoretical framework for this study is the fourth industrial revolution—Industry 4.0—as it intersects with the practice of lean and specifically with process design and development. Today, organizations are integrating technology into their processes and relying on workflow tools to navigate work through the organization structure imposed onto the work process. This observation especially applies in transactional work, back-office types of work, and knowledge work. It is important to be able to study *flow* through the processes and to build reporting that sheds light on the work being performed. These insights are often hidden in the data captured by information technology systems. This paper aims to share an approach I have developed to see and understand the elements of flow, called a flow analysis. The flow analysis converts captured data into insights about the dynamic movement of work through a process. This study focuses on transactional processes and the application of adapted manufacturing mathematical concepts, such as Little's Law, to transactional processes. The research presented does not appear to have a known precedent in literature and may be considered groundbreaking.

Key Words: Industry 4.0, Data Insights, IT-Systems, Flow Analysis, Little's Law, Transactional Process, Lean, Business Process Architecture, Organization

Problem Statement

As part of Industry 4.0, organizations are integrating technology into their processes and relying on workflow tools to navigate work through the organization structure. This observation especially applies in transactional work, back-office types of work, and knowledge work. It is important to be able to study *flow* through the processes and to build reporting that sheds light on the work being executed. These insights are often hidden in the data captured by information technology (IT) systems. Because the organization structure is imposed onto the work process, it is important to be able to map the information within an IT system. Further, sometimes more than one IT system is used to navigate work through the organization structure. Often, integrations between IT systems are questionable, which makes visibility into flow and what might be obstructing flow difficult to see. This lack of visibility results in delays and slower speed, which forces customers to wait. For many businesses that compete on speed in addition to quality, this lack of visibility can have a negative effect on service fulfillment. This paper aims to share an approach I have developed to see and understand the elements of flow, making use of the data captured in workflow tools in the form of a flow analysis.

Significance of the Research

The method described in this article is significant to business operations because it creates visibility into the flow of units of work through the process that creates value for the enterprise. Flow through a process contributes to inventory turns, which contributes to revenue and service fulfillment for customers. Understanding the elements of flow is also important because business measures its performance using key performance indicators (KPI) that are business focused (KPI_b), and oftentimes those KPI need to be translated into process performance indicators (KPI_p) that are closer to the work and more relevant to the operations found deeper in the organization hierarchical structure. Organizational failure

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to translate KPI_b into KPI_p restricts the actionable responses to improve business performance: increasing price, reducing head count, for example. Learning how to translate the business performance indicators into process performance indicators enables operations to improve performance. It is essential for organizations to understand the elements that make up flow through a process, as well as identify the units of work wait that result in delays. The method described in this article can be applied to any operation within a business enterprise and has merit due to this flexibility.

Many departmental operations within three distinct businesses and industries have used the approach described in this article:

- Sales
- Marketing
- Finance/credit
- Sourcing
- Ethics and compliance
- Laboratory testing operation
- Warehouse inventory management
- Engineering service operations
- Software development operations
- Audit operations
- Magazine subscription and publication
- Membership renewal

The distinct industries include the professional services industry, subscription as a service, and trade organization.

IT systems used include Oracle, Microsoft Dynamics, SalesForce.com, Open Air, WebDB, and other "home-grown" IT systems.

Theoretical Framework for the Study

The theoretical framework for this study is the fourth industrial revolution, or Industry 4.0 (Ullah, 2020, p. 1), as it intersects with the practice of lean and specifically with the practice of process design and development (Constantinescu, 2020, p. 6) within lean. Further, this study addresses the nexus among process design, "factory physics," which relies on Little's Law, and Industry 4.0. Little's Law is a mathematical theorem, a tautology (Little & Graves, 2008) that states that the cycle time to get through a system is equal to the work in progress divided by the throughput for a given system (Hopp & Spearman, 2000, pp. 223–225). This relationship is important to operations managers who are concerned with service fulfillment. According to Ullah (2020), "In Industry 4.0, humans, technology, and organizations are integrated in both horizontal and vertical manners using advanced information and communication technologies" (p. 2). This research focuses on the conversion of captured data from IT systems into insights or knowledge *about* the flow of work through a process. The term *flow* in this context refers to the continuous and dynamic progression of work through a process. This study focuses on transactional processes and the application of adapted manufacturing mathematical concepts to transactional processes.

Lean is a practice that originated in manufacturing, focusing on designing processes to enable flow and visibility and to eliminate or reduce waste in a process. In this context, the traditional wastes found in the process obstruct or hinder flow. *Waste* is considered work that is non-value-added in the eyes of the customer; the customer would prefer not to pay for that work. Traditionally, there are seven wastes: transportation, inventory, motion, waiting, over-producing, over-processing, and defects. Recently, an eighth waste, not using talent, joined the list. Each of these wastes hinders flow and adds *time* to the process. We care about this because "for customers who are concerned about time, the perception of the time spent waiting is a better predictor of satisfaction than the actual waiting time" (Davis & Heineke, 1998, p. 64). Because each of the "wastes" adds time to the process, which contributes to customers waiting, we need to study the process to understand the distinction between the time it takes to do the work and the time it takes to get through the process. In the ideal state—i.e., in a process without waste—the time it takes to get through the process is the same as the time it takes to do the work (Costanza, 1996).

The presence of waste in the process causes these two time-based measurements to vary. Therefore, waste is a barrier or hindrance to flow and slows the progression of work through the process. In the manufacturing environment, one can physically see waste within the space. In the transactional environment, professional services industries, back-office processes, and knowledge work, waste is less visibly obvious as it is hidden within the processes, which are executed not on an assembly line but rather through IT system(s) and across the organization. The challenge is to tap into the data captured in the IT systems to understand the elements of flow (Constantinescu, 2017), which will enable conversations about the hidden wastes in the process.

In his writing, Costanza (1996) explains that processes can be designed with intention to enable flow to meet customers' demands. He referred to this as "demand flow technology." Costanza writes for what he calls a "mixed-model demand" manufacturing environment, which means the process is not creating "widgets," but rather is more like a job shop in which there is variation in the mix of work coming into the organization and the steps involved in fulfilling the work. In transactional processes in the service sector and in back-office types of processes, the mix of work and the variation in steps needed to fulfill the work is analogous to Costanza's mixed-model flow.

The elements that comprise what I refer to as the *flow analysis* are adapted from Costanza's (1996) "Demand Flow Technology" concept described in his book *The Quantum Leap: In Speed to Market*. Costanza introduces Total Demand and Daily Rate. In this paper, these terms are adapted from the manufacturing context to the service/transactional context in the following way:

- Total Demand is simply called Demand (D). Costanza (1996) explains that Total Demand is the greater between forecasted order volume and actual order volume in the period in question (p. 341). This definition is adapted slightly for service/transactional processes because the operation does not rely on a forecast, per se. In the service environment, orders begin with a customer and represent incoming work. I refer to incoming work as Demand (D).
- Daily Rate is simply called Throughput (TP) (Costanza, 1996, pp. 325, 341). Costanza explains the Daily Rate as being the number of *good*-quality units produced at the end of the time period in question (p. 325). This definition is adapted slightly for the service/transactional processes because we are concerned with units of work that represent the complete fulfillment of the customer order; unlike a manufacturing process, completed units of work simply exit the process, indicating that the fulfillment is complete. I refer to units of work that exit the process as Throughput (TP), in line with the language Hopp and Spearman (2000) use in describing Little's Law.
- To address the quality dimension in Costanza's Daily Rate, I use different forms of Yield, depending on the type of transactional process.

In transactional processes, the data stored in the IT systems can be used to see units of work entering a process and units of work exiting a process. D and TP can be studied to see if the volumes of incoming and outgoing work are stable over time. It is important to see if TP keeps pace with D. If it doesn't, that means that work-in-progress (WIP) inventory is growing. Because of the relationship among WIP, TP, and cycle time known as Little's Law, if WIP inventory grows, the cycle time slows down (Hopp & Spearman, 2000). This scenario has service-level and customer satisfaction implications. Conversely, in a process that has a large WIP inventory, the reduction of WIP inventory results in faster operation. Tapping into the data stored in the IT systems to understand the flow of work through the process is helpful.

Tapping into the technology is not a new idea. The use of technology in our organizations to improve communication and solve complex problems has evolved since the 1950s (Mukherji, 2002, p. 498). Indeed, "it was in 1957 that the USA passed from the industrial era to the information era. . . . The number of employees in the country whose jobs were primarily handling information surpassed the number of industrial workers" (Mukherji, 2002, p. 498). Further, computers have been used in business areas such as planning, R&D, engineering, marketing, procurement, production, storage, distribution, operations and service, and management, in addition to budgeting simulation, automation, and as a tool for information and making decisions (Mukherji, 2002, p. 498). In addition, as the technology evolved, organization structures also evolved.

The evolution of both technology and organization structure is important to understand, as it connects to process design and flow of work through the process. The organization structure is imposed onto the work processes and those work processes are enabled by the technology in the form of IT systems. This reality is important to understand because it speaks to two blind spots that need to be recognized: (1) differing IT systems within different departments, and (2) differing levels of detail within a single IT system.

Blind Spot One: Sometimes different departments within the same organization use different IT systems to do the work and to route the work across departments. While the creation of units of work in a second system might involve manual duplicate data entry, which in itself might be considered motion waste or over-processing waste, the fact that work in the first system is no longer being acted on within that same system creates a blind spot in visibility. Many times, a department or operation might build reporting capability limited to the information contained in the single IT system. While this reporting is important and necessary, it can also be a blind spot because it fails to reveal what work might be waiting elsewhere in the different IT system. Such a blind spot exists if work is fulfilled in more than one IT system within the organization.

Blind Spot Two: This condition relates to the level of detail described within a single IT system. Many times, within a single IT system, the tool is configured to track the progress of work through different stages of the process and to enable the routing of work to different resources in the organization. Awareness of this tool configuration is important because processes exist within a business process architecture (BPA), which means the level of detail that needs to be understood about the work is not limited to the highest level, nor is it limited to the workflow routing rules programmed into the IT system. When businesses rely only on the stage level captured in the workflow tool, they inadvertently oversimplify their understanding of the work content involved to fulfill the service. For example, a basic "lead to order" process in an organization might be configured at the highest level to have four high-level phases, yet at the point of work, which is where the human being interacts with the process, there might be 50 steps to move the unit through the process entirely. When the reporting in the organization is limited to the high-level phases captured in the IT system, it fails to reveal the actual complexity of the work at the point of work, which is deeper in the BPA.

Although this article does not expressly provide specific corrective recommendations for the two blind spots, it does address the method of mapping the information flow for a process in order to see the elements of flow: demand, throughput, work in progress, turnaround time, aging, and yield. To that end, this paper aims to address the following questions: What elements of flow are important to see using the data captured by the IT systems? Can we track key process performance indicators (Costanza, 1996) from the data captured in the IT systems? This is important to operations because businesses rely on workflow tools to route work through the organization, and therefore it is requisite for businesses to track and monitor the work through the process and through the organizational structure.

Method

In a *flow analysis*, we are interested in seeing the volume of work entering the process, exiting the process, and aging in the process. We are interested in understanding how long it takes to get *through* the process. We want to understand *where* units of work might be stuck in the process, which means waste is present in the process. We are interested in understanding how well client due dates are being met. Each of the elements of flow listed below can be studied using the data captured in the IT system for unique transactions in the system.

To begin, the following elements of flow can be seen:

- Demand (D) – Incoming units of work or units of work entering the process.
- Throughput (TP) – Outgoing units of work or units of work exiting the process.
- TP minus D – For a given period, which is greater: TP or D? This sheds light on the growth or shrinkage of WIP.
- Work in Progress (WIP) – Units of work that have entered the process and have not yet exited the process.
- Turnaround Time (TAT) – The time it takes to get *through* the process from the time of entry to the time of exit.
- Aging – The amount of time the WIP is open, or alive, in the process.
- Process design efficiency – Time it takes to do the work divided by the time it takes to get through the process (Costanza, 1996). The denominator in this equation is the TAT.
- Yield in terms of Met Due Date – The capability of the process to complete on or before the specified due date, divided by the total units that exit the process in a period.
- Yield in terms of Win Rate (limited to a sales process) – The proportion of transactions that exit the process in the "won" state, divided by the total transactions that exit the process for a period.

To conduct a flow analysis, the first step is to develop the process architecture with IT system date stamp mapping. The objective of this visualization is to identify the labels and language used in a given configuration that supports a process. The intention is to capture the high-level phase, the date stamps as each occurs along the flow, unique identification numbers at the point where each is created in the system, and transaction status changes as a unit of work moves through the process. Getting this information involves working with individuals who

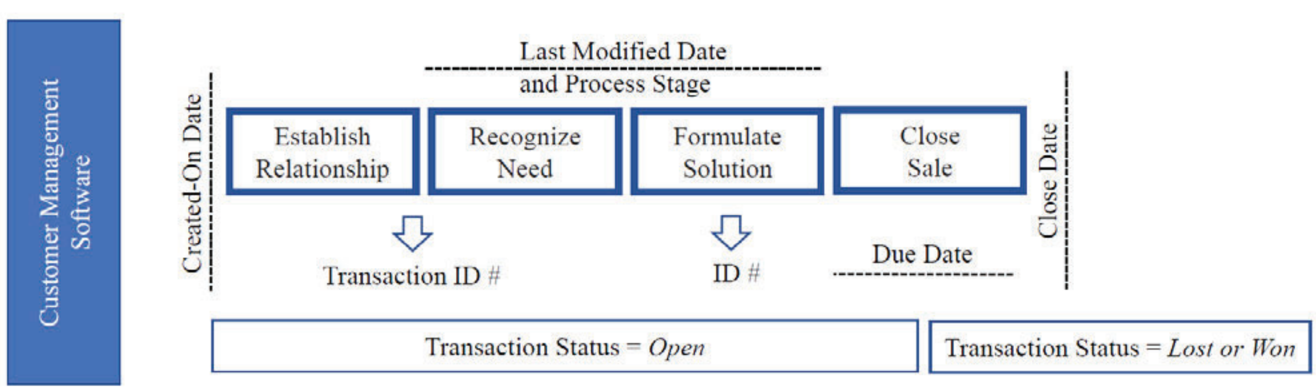

Figure 1: Process Architecture with Date Stamp Mapping

understand the database configuration and data storage structure, IT resources with access to retrieve data from the server, and the individuals who actually do the work in the process. The process architecture with the date stamp map needs to be documented at the phase level (L0), sometimes called a Stage in the BPA (Constantinescu, 2020, pp. 16–20). Refer to Figure 1 as an example of a generic lead-to-order process with date stamp mapping. In Figure 1, note that *time* moves from left to right, which means that certain work must be completed before some of these dates and fields are captured in the IT system. This understanding is critical because it is based on this that *logic* can be used to study elements of flow through the process.

Once the date stamp process map is created, the elements of flow can be studied. For the process depicted in Figure 1, demand can be seen using the Created-On date. The count of units entering the process each week can be aggregated and plotted in an I-MR Control Chart to see if D is consistent and predictable, or if there are seasonal patterns in D. Similarly, to understand TP, the count of units exiting the process can be seen based on the Closed date. There might be a repeating "hockey stick" pattern to TP (Costanza, 1996). This hockey stick pattern might appear by day of the week, week of the month, or month of the year. This observation is important because it reveals behavioral patterns in the operation. It is helpful to look at the difference between TP and D each week to get an understanding of the WIP. If TP is greater than D, WIP in the system is shrinking. If TP is less than D, WIP is growing in the system (Costanza, 1996). This observation is important because of the relationship between WIP and the time it takes to get through the process (Little & Graves, 2008).

In addition to understanding D and TP, we want to see the actual WIP inventory in the system. To see WIP, count the number of transactions with a Created-On date where the Closed date is null. This count is an aggregate of the WIP and is a "snapshot" in time. *Aging* of the WIP can be quantified based on the difference between the date the report is retrieved from the system minus the Created-On date for the transaction. Once Aging is quantified for open transactions, visibility into the approaching due dates can also be created.

For all transactions that have closed, the TAT can be quantified. TAT is what Costanza (1996) refers to as "total time" and consists of all the value-added time plus the non-value-added time (p. 46) in the process. TAT is also what Little's Law refers to as cycle time. As explained previously, Little's Law is a mathematical relationship that states that the cycle time to get through a system is equal to the work in progress, divided by the throughput for a given system (Hopp & Spearman, 2000, pp. 223–225). TAT is the time it takes to get through the process from the point of entry to the point of exit. TAT is historical in that a unit of work must exit the process before one can calculate TAT using the date-difference calculation. TAT is determined by taking the difference between the Closed date and the Created-On date. Sometimes, there might be a parent–child relationship in the data that corresponds to a single customer order. If this is the case, that relationship might need to be considered when calculating the TAT on closed transactions. For example, a single order might have multiple line items. In this case, to understand the maximum TAT at the order level, use the *minimum* Created-On date and the maximum Closed date. This date difference represents the *maximum* TAT associated with the order.

In addition, when we understand the time it takes to do the work and compare that to the time it takes to get through the process (TAT), we are able to understand what Costanza (1996) calls "process design efficiency" (p. 46). In the transaction environment, the process design efficiency concept is adapted slightly. In the numerator, include the work content time (WCT) for the process, which is the time it takes to do the work in the process, including value-added actions and business-value-added actions. In the denominator, include the overall TAT for the process. The TAT is the WCT plus waiting time. The ratio of WCT/TAT is multiplied by 100 to understand the process design efficiency (sometimes called process cycle efficiency). This view of efficiency is important because it deals only with time. It is not a measurement of revenue per headcount, nor is it a measurement of units per person. Both the numerator and denominator deal with time related to the process. This is an important translation from typical input/output definitions of efficiency to process-focused definitions of efficiency. In the ideal case, process design efficiency is 100% (Costanza, 1996).

In addition to the above elements in the flow analysis, we can also understand the Yield. Yield is a key process performance indicator (KPI_p) (Constantinescu, 2020, p. 99) and is a type of process capability measurement taken at the end of the process. Conceptually, Yield is the number of good units exiting the process, divided by the number of total units exiting the process; this ratio is then multiplied by 100. In the transactional setting and depending on the type of process, Yield might be defined in different ways. In Figure 2, there are two forms of Yield that are worthy of study.

The first is Yield in terms of *Met Due Date %*. The Met Due Date % can be plotted in a P-chart each week. It tracks the proportion of units that closed on or before the due date, divided by the total units that closed in the period. From Figure 2, the Met Due Date % can be seen by comparing the Closed date to the Due date for each transaction that exited the process.

A second Yield measurement for this process is in terms of the proportion of transactions that are "won" instead of "lost." This form of Yield is sometimes referred to as *Win Rate* and is typically for a sales type of process. Win Rate can be seen by plotting the proportion of transactions that exit the process in the "won"

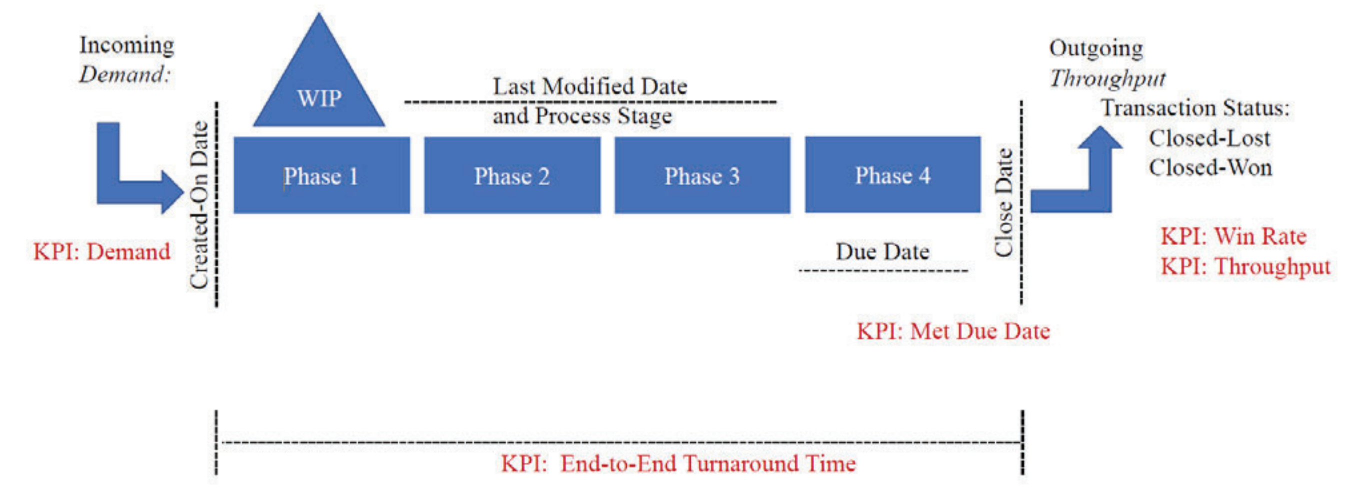

Figure 2: Flow Analysis Framework

state, divided by the total transactions that exit the process for a period.

The elements of flow can be studied from the data captured and extracted from the IT system. Figure 2 shows a general flow analysis framework with the elements that need to be studied, as well as some of the raw data fields that need to be extracted from the system in order to do the study. In addition to the KPI_p (D, TP, Win Rate, Met Due Date, TAT), the work in progress inventory can be seen for each stage in the process.

Results and Analysis

The results presented below refer to the study period 2020–2021 regarding a professional services industry with over 10,000 employees worldwide. From the extracted data, it is possible to understand flow of units through the process and also define and measure key process performance indicators. While the data were extracted from the IT system and analyzed according to the method described above, they were filtered in three different ways:

- The entire dataset was used to study Demand.
- A subset of the dataset was used to study WIP corresponding to an open Transaction Status.
- A subset of the dataset was used to study TP, TAT, and Yield corresponding to transactions that exited the process.

Figure 3 contains the Flow Analysis Summary Diagram. In this process, there are four stages: Establish Relationship, Recognize Need, Formulate Solution, and Close Sale. Each transaction entering this process is created in the IT system and a Transaction ID Number is generated. The date stamp mapping for this process reveals four dates: Created-On date, Closed date, Due date, and Last Modified date. Based on these dates, along with the transaction status, process stage, and unique identification numbers, the flow analysis was conducted.

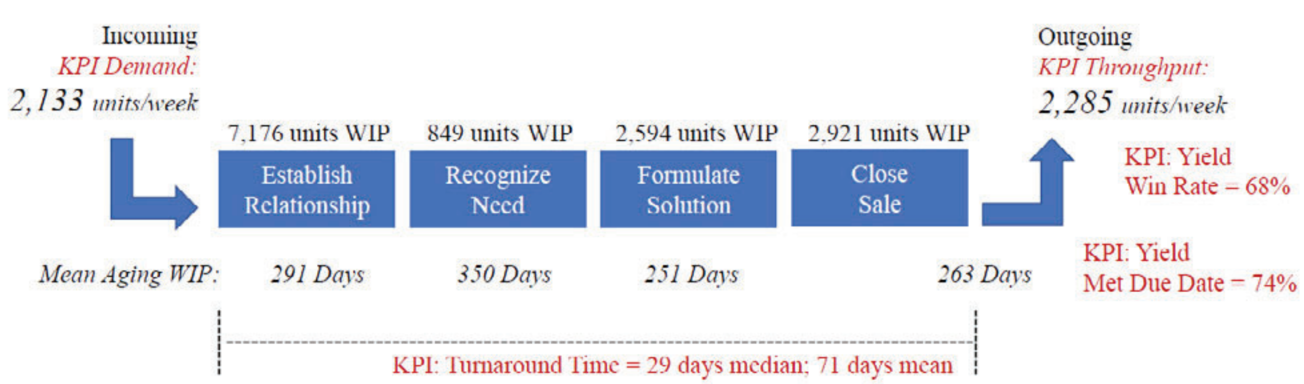

Figure 3: Flow Analysis Summary Diagram

Historically for this process, 2,133 units enter each week, and 2,285 units exit each week. The average time it takes to get through the process is 71 days (29 days median). When looking at the throughput of the process, we can see that the Win Rate is 68% and that this process meets due dates 74% of the time. There are 13,540 units of WIP in the process distributed across the stages. The current WIP is aging. The magnitude of the aging exceeds the historical average TAT. We cannot discern from these data whether the WIP is "phantom" WIP and might need to be cleaned out of the IT system. We can only see that the WIP is high and the aging is high, which will lead to longer TATs (Little & Graves, 2008).

Demand was counted weekly based on the Created-On date and plotted in an I-MR chart staged by year. The weekly incoming demand was 2,133 units per week in 2021. All transactions in the data set were included in studying demand because, regardless of the Transaction Status, the unit of work entered the process at a specific point in time.

The units that exit the process are considered TP, which can be seen based on the Closed date for all transactions *excluding* those with an open Transaction Status. The Transaction Status is important to consider when quantifying TP because some IT systems have a date populated in the Closed date field, which might represent an estimated due date in the future instead of reflecting the actual date the transaction closed. To discern the difference, rely on the Transaction Status. The average weekly TP count in 2021 was 2,285 units per week.

Using the TP dataset, the TAT was quantified for each transaction using the difference between the Closed date and the Created-On date. In 2021, on average, it took 71 days to get through the process. Median TAT indicates that it took 29 days to get through the process.

In addition to D, TP, and TAT, we can understand the WIP in the system using the dataset that corresponds to an open Transaction Status. At the snapshot in time when the data were extracted from the IT system, this process had 13,540 units of WIP, 71,103 units that were "lost" and 144,178 units that were "won." For the open transactions, this view does not reveal *where* in the process the units are; it simply reveals how many units are open, representing *work in progress*. Using a basic pivot table, the WIP can be distributed by Stage in the process. At the time of this study, 7,176 units are in the first step, Establish Relationship; 849 units are in the second step, Recognize Need; 2,594 units are in the Formulate Solution step; and 2,921 units are in the last step, Close Sale. By taking the difference between the date the data were pulled from the IT system and the Created-On date, we can understand the average aging of the WIP in each stage of the process. This aging represents the total age of the WIP, not the time it spent in each stage.

Two forms of Yield were studied using the dataset for TP. The first way to understand Yield for this process is the Met Due Date %. For this process, when we compare the actual Closed date to the Due date, we can understand how well the process meets the target date. The numerator represents the count of units that closed on or before their due date. The denominator represents the count of all units that closed in the period in question. In the aggregate, we can see that the process can meet the due date 74% of the time. When plotted weekly in a P-chart, we can see that the process's ability to meet the due date is *unstable.* The data are silent on why the process is unstable. In this context, an unstable process might be significant because customers care about timelines and due dates. This KPI_p constitutes an area for continuous improvement.

Because this is a sales process, a second way to measure Yield—Win Rate—can be seen from the same dataset. Win Rate aims to understand the percentage of units exiting the process that are considered "won," divided by the total units exiting the process in the same period; that ratio is multiplied by 100. The overall Win Rate can be determined through the count of transactions with a status of Closed "won," divided by the count of transactions closed in the period in question (where the count of transactions closed in the period is the sum of Closed "lost" and Closed "won" transactions). From these data, we can see that the "won" count is 144,178; the total count is the sum of "won" plus "lost" transactions, which is 215,281. This ratio is expressed by $(144{,}178/215{,}281) \times 100 = 67\%$. Understanding the overall Win Rate for the entire study period does not let us see if this Win Rate is consistent over time. To see if the Win Rate is stable over time, plot the data in a P-chart. In this process, the average weekly Win Rate is 67% over time and is statistically *unstable*, a fact that is not articulated via the data. In this context, the instability of the process to win the sales has business implications and might warrant improvement of the sales process.

The insights derived from the flow analysis also catalyze questions for continuous improvement efforts to better serve the customer. In this example, one might ask:

- Can the Win Rate be improved?
- Can meeting the Met Due Date % be improved?
- Can the TAT be reduced?
- What wastes are in the process that are contributing to the long aging?
- Can we study the touch time at each step to understand process design efficiency?
- Do we have enough capacity to handle the volume of work?

These are important questions to ask. A business measures itself in terms of business performance indicators such as revenue, cost of revenue, revenue per head count, and operating profit. Yet many of the business performance indicators relate to the processes that represent the work that gets done through the organization. Converting the data into insights that reveal the flow of units of work through the process translates the business performance indicators into process performance indicators (Costanza, 1996). These are measurements of the process directly and can be improved continuously because they are closer to the work itself and therefore are actionable at an operations level.

Conclusion/Discussion

Exceedingly today, businesses rely on IT systems to route transactional work through the organization for fulfillment. The process used in transactional work can be hidden in the IT system. The flow analysis method described here creates visibility into the flow of units of work through the process. This visibility catalyzes continuous improvement to reduce waste in the process as well as creates visibility into what work needs to be done on the units that are in the system and that are aging. The benefit to business operations is reducing TAT and improving process efficiency.

The factory physics principles from manufacturing, such as Little's Law and Costanza's "Demand Flow Technology," also apply in the transactional environment. In his work, Costanza adapted the principles from manufacturing for a mixed-model manufacturing environment. Transactional work and knowledge work is similar to the mixed-model Demand Flow Technology adapted only for the service environment. The work does not happen in a physical manufacturing facility but rather in and through the IT systems. Our task is to be able to make visible what is hidden in the IT systems so that the organization can continuously improve its processes for both customers and employees.

While this study makes good progress in creating visibility into flow, it does have limitations. This study does not address process mapping deeper into the BPA. This is an area that needs more explanation, especially when applied in transactional and knowledge work. What actually gets standardized in the process when it comes to transactional and knowledge work? This study also does not address studying flow across more than one IT system. This is an important area that needs more research. A single transaction of work can be aging in more than one IT system within the organization. How can we extract the data out of the IT systems to reveal where transactions are stuck waiting as a result of the organizational handoffs that coincide with a change in IT systems? This is particularly important to improve process design efficiency. Although mentioned as an element in the flow analysis, process design efficiency is not addressed in this study. More research is needed in adapting this KPI_p for transaction and knowledge work processes.

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