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An "à la Ansoff Weak Signal" Feedforward Control for Pharmaceutical Distribution

A pilot study on standard operating procedure for managing customer complaints

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***Abstract*—Feedforward controls (i.e., preventative controls), as opposed to classical feedback controls (i.e., corrective controls), are based on the early detection of risks and the implementation of solutions before damage occurs. However, despite their inherent advantages (e.g., increasing the flexibility of supply chains), feedforward controls remain underdeveloped in the pharmaceutical distribution sector, largely due to the tediousness of identifying applicable anticipatory indicators. To properly anticipate the achievement of business objectives, in our in-depth case study of a Swiss wholesale distributor of pharmaceutical products we relied on the notion of weak signals as conceptualized by Ansoff to develop a conceptual framework of feedforward. We identified a weak signal that showed more occurrences of error when less versatile employees were involved in executing tasks. The standard operating procedure for customer complaint management was recently adapted to include a feedforward control based on the weak signal.**

Keywords-error occurrence; feedforward control; pharmaceutical distribution; supply chain management; weak signal

I. CONTEXT

Supply chain management is the backbone of pharmaceutical distribution. Medicines are dispatched to drugstores, pharmacies, hospitals, doctors, and social healthcare establishments. In pharmaceutical supply chains, medicines and drugs distributed contain expensive active substances that have been carefully traced from origination to destination. However, perhaps for that reason, such supply chains are also exceptionally liable to encounter threats such as counterfeiting, diversion, cargo theft, and the importation of unapproved medicines [1]. For that reason, the European Union and the U.S. Food & Drug Administration (FDA) have imposed stringent regulations upon pharmaceutical distribution. The European Commission has also redacted guidelines on good distribution practices with the aim to "control the distribution chain and consequently maintain the quality and the integrity of medicinal products" [2].

According to the glossary of the Institute of Internal Auditors [3], the term *control* refers to "[a]ny action taken by management, the board and other parties to enhance risk management and increases the likelihood that established objectives and goals will be achieved." Control is thus an important part of managerial activities.

In practice, a control corresponds to a three-step process: 1. the definition of the goal, 2. the measurement of the achievement of the goal within the time limit, and 3. managerial correction—that is, do nothing if the goal is met, reconsider the goal if it is overly ambitious, and establish risk-mitigation treatments to increase the likelihood of achieving the goal.

When control is corrective (i.e., feedback control), managerial correction is triggered on the basis of an objective measurement of the achievement of the goal—that is, after the attempt of achieving it. However, when the control is anticipated (i.e., feedforward control), the measurement of the achievement of the goal is replaced by a forecast of the achievement.

In our research, we explored the possibility of designing feedforward controls based on weak signals as anticipatory indicators. In particular, we conducted an in-depth case study at Valpharmex, a high-end medicine wholesaler in Switzerland. The goal of our research was to construct a conceptual framework of management control to improve the performance of pharmaceutical distribution supply chains. In this paper, we report findings regarding one of our hypotheses: that a relationship exists between employee versatility and the rate of error occurrence in supply chain activities. We developed a pilot experiment in which we integrated a feedforward control into the current standard operating procedure (SOP) for managing customer complaints at Valpharmex. The feedforward control is fed by weak signals that anticipate the lack of versatility among employees working on the supply chain and enables management to mitigate the risk in to reduce error and thereby improve the management of customer complaints.

In Section II of this paper, we briefly review literature on weak signals [4] as early warnings in supply chain management and feedforward controls [5] grounded in cybernetics, also as applied in supply chain management. In Section III, we explain the methodology employed in our exploratory research. In Section IV, we report and discuss the chief findings of our research. In Section V, we show how a feedforward control based on a weak signal has been implemented at Valpharmex for the purposes of observation. In Section VI, we state our conclusions and indicate directions for further research.

II. Literature Review

A. Weak Signals

In his seminal article on weak signals, Ansoff explained that anticipatory planning for a firm is critical to its durability [4]. Moreover, he posited, the handling of discontinuity can be anticipated by diverse forecasting techniques as long as the correct information is available. In turn, factual information can be converted to actions and plans in the context of strategic planning in any given organization. The true difficulty is having relevant, accurate data at the right time. Even then, information and strategic planning are useful only if two additional conditions are met. First, data have to be available early enough so that the company can react correctly and thoughtfully. Second, the forecast has to be complete and as exhaustive as possible. It is therefore pivotal to know the potential impact of the identified signal on the firm [4]. Ansoff concludes his article by asserting that the weak signals could be a way to gather the needed facts early enough to react [4]. The difficulty with weak signals is that the term has no clear definition, which makes it impractical despite its immense popularity in management. Different conceptions of the notion of weak signals have indeed emerged since Ansoff's seminal work [6].

Among them, Ansoff himself defined *weak signals* as "warnings (external or internal), events and developments which are still too incomplete to permit an accurate estimation of their impact and/or to determine their full-fledged responses" (in [6]).

Much later, Schoemaker, Day, and Snyder, assuming that firms focus only on their immediate environment—the familiar landscape—posited that weak signals can also occur outside that environment and, in response, developed a strategic radar system [7].

To know which signals are important and which are mere noise, signals need to be amplified, as is well known in other fields such as electronics. Regardless of field, the goal of signal amplification is always the same: to amplify weak signals contained in a great deal of noise in order to be able to capture a global trend [8, 9].

After discovering such signals, organizations can react or adapt to them. Ansoff established two categories of responses: change the relationship with the environment or change the internal dynamic and structure of firm (cited in [10]). As summarized by Cevolini, because "social systems cannot observe themselves from the outside, the issue of weak signals should be explained as the outcome of a self-referential dynamics that finally leads to the paradox of knowing the unknown" [11].

There is always an aspect of risk posed by weak signals that an enterprise must manage. In supply chains, weak signals can be significant; breaks interfere with the normal flow of goods, possibly due to breakdowns in transport or quality-related problems with the products [12]. Such disruptions constitute a risk for companies because they can have financial impacts [13]. As explained by Tomlin, firms need to have an optimal disruption management strategy to mitigate those risks [14]. Each enterprise develops numerous tactics to manage the various risks as well as possible, and to minimize them, they "take action in advance of disruption" [14]. In that approach, weak signals can be tools to collect the needed information early enough to avoid disruptions in the supply chain.

B. Feedforward Control

Currently a concept applied in different fields, feedforward control was first introduced by Wiener (1984) in *Cybernetics, or Control and Communication in the Animal and the Machine*, specifically in his general theory of organizational and control relations in systems [5]. In the following section, based on the work of Heylighen and Joslyn [15], we explain the cybernetic aim of feedforward control to clarify how systems operate.

High-level concepts such as order, organization, complexity, and structure are used to explain the relationships between elements composing a system. For that reason, cybernetics is employed in different domains, in which the major contribution of control relates to goal-directed behavior.

To achieve goals, a system has to be controlled in different ways. In fact, internal or external elements can disrupt the entire system. So that the system achieves its goals, the effects of disturbances have to be regulated in three ways: by buffering, by feedback, and by feedforward. With buffering, the system is passive and absorbs the disruption. By contrast, feedback regulation "compensates an error or deviation from the goal after it has happened" [15]. Feedforward regulation, similar to feedback, needs action to eliminate the effects of the disruption. Unlike feedback, however, feedforward deletes the disturbance before it affects the system. To anticipate problems, it is necessary to know how the system will be affected by such disturbance. Regardless of field, the goal is the same: to change the system before it is affected by the disturbance. To do that correctly, it is important to know how the system can be affected [16, 17, 18]

The feedback control (Figure 1), in the most common strategy, measures the output and compares it with the required value. The feedforward control (Figure 2) takes into account perturbations by measuring them and applies control action accordingly [19].

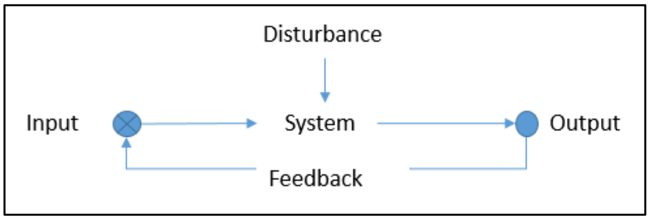

Figure 1. Feedback control, adapted from Hopgood [19]

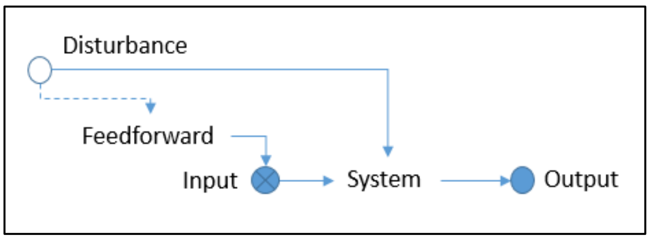

Figure 2. Feedforward control, adapted from Hopgood [19]

Hollnagel has explained another important difference between feedback and feedforward [20]. With feedforward, the signal control comes from expected differences instead of actual ones. An advantage of that characteristic is the improved efficiency of control because the possible impacts are anticipated.

In the field of business, the notion of control is known as part of the management control system and has been defined by Anthony as "the process by which managers ensure that resources are obtained and used effectively and efficiently in the accomplishment of the organization's objectives" (cited in [21]). Pavlov and Bourne have argued in their research that feedforward communicates performance priorities and gives guidance in the development of organizational processes and in anticipating the direction of change [22].

Schreyögg and Steinmann have observed the need to have an alternative model to the classical feedback control [23]. They argue that companies have difficulties in reacting to planning failures and unexpected development due to a lack of information, which exposes two chief problems: post-action control and standards are taken for granted. To have enough information to gauge whether the strategy is congruous to the environment, they propose to apply Ansoff's weak signals and advocate integrating them in a feedforward control setting. In this paper, we report the development of what to our knowledge is the first conceptual framework of a feedforward control based on weak signals.

III. Methodology

We employed an exploratory approach to construct new theory regarding feedforward controls.

As advocated by Yin, a case study is an in-depth enquiry into a topic—in our work, the traceability process in a real-life setting [24]. Eisenhardt defined the goal of case study research as the understanding of the dynamics between the major subject of the research and its context [25]. In that sense, the strategy of case study research is often grounded on interpretivism.

Our case study focused on Valpharmex, a pharmaceutical establishment authorized by the Swissmedic Health Authority in Switzerland and a wholesale distributor of pharmaceutical products abroad. Founded in 2008, Valpharmex is a family-owned company based in Wallis since 2010. Owing to an internally developed purchasing trading information system, the company can optimize the sourcing of suppliers for its pharmaceutical customers, who Valpharmex assures an excellent quality of distribution within the strict pharmaceutical regulatory framework of European Good Distribution Practices.

Qualitative data were collected via semistructured interviews conducted at Valpharmex that had three important objectives: to understand the traceability process, to comprehend relationships between the different departments, and to gather weak signals and tacit knowledge. A dozen such interviews were conducted in French during the spring of 2017.

Transcripts of the interviews were thematically reviewed with the software R and the package RQDA, which Braun and Clarke have attested afford systematic flexibility and accessibility [26]. All transcripts were coded with seven keys: changes in technology, changes in process, controls, mistakes, current processes, quality, and traceability.

Interviews were complemented by immersion episodes (i.e., non-participative observations) conducted on the supply chain site of Valpharmex.

In sum, the research process followed different steps for an iterative instead of linear process. First, we conducted a thorough literature review to determine the state of the art of research on weak signals and feedforward control. Second, based on that review, we generated a priori hypotheses. Third, we conducted a series of semidirected interviews. Fourth, we analyzed collected data using content analysis supported by RQDA based on codes and categories of codes from the literature review. Sixth, we triangulated the results with immersion episodes and with findings obtained from the literature. Seventh and lastly, we developed a new theoretical framework for a feedforward control based on weak signals.

IV. Findings and Discussion

The quality of Valpharmex's services is typically determined by the number of mistakes in identification and shipping. Based on the interviews administered to the employees, we have hypothesized that the versatility of employees decreases the occurrence of errors. Versatility of the employees was therefore the independent variable and the occurrence of errors the dependent one.

More formally:

H0: There is no relationship between the versatility of employees and the occurrence of errors.

H1: There is a relationship between the versatility of employees and the occurrence of errors.

To define both notions present in the hypothesis and allow a common understanding, the *versatility* of employees can be explained as their capacity to perform different tasks with various functions and diversify their field of competence in light of training (Field 1994 cited in [27]). The chief purposes of versatility, at least according to Hopp and Van Oyen, are to increase they flexibility of the company and improve the allocation of human resources [28].

The second variable of the hypothesis is the occurrence of mistakes. According to the definition in the *Cambridge English Dictionary*, an *occurrence* is “something that happens,” and a *mistake* is “an action, decision or judgement that produces an unwanted or unintentional result.” *Merriam–Webster Dictionary* defines an *error* as an unwanted deviation from objectives or truth (cited in [29]). Researchers have concentrated their work on action errors—deviations from goals or actions resulting from a lack of knowledge—and explained that mistakes can provide employees with negative feedback. Errors can also have positive consequences such as improving the learning curve [29].

Is multitasking truly a way to reduce mistakes in a company? To find out, we searched the scientific literature for a model integrating those different aspects and identified the job characteristic model of Hackman and Oldham [30]. The model explains that “an individual experiences positive affects to the extent that he learns (knowledge of results) that he personally (experienced responsibility) has performed well on a task that he cares about (experienced meaningfulness)” [30]. The model evaluates five job dimensions—skill variety, task identity, task significance, autonomy, and feedback. An interesting notion not integrated in their model is task variety, or the number of different tasks performed by an employee [30], which Humphrey, Nahrgang, and Morgeson specify should not be confused with skill variety [31]. Task diversity is positively linked with job satisfaction and perceived performance [32], and Hackman and Oldham seem to have integrated the notion in their research [33]. Task variety not only positively affects the commitment of employees but can also has distraction potential and can benefit personal performance and, in turn, turnover [34].

V. Control Implementation

As mentioned, we have tested this hypothesis at Valpharmex. The following section presents the control implementation in the company. The weak signals identified as significant for the quality of the service are also described.

Its pharmaceutical environment is governed by a quality assurance system (QAS) implemented within the company. There are 11 written procedures, called SOPs, within the QAS that address order management, protection against counterfeiting, employee training, and customer complaint management (SOP VPX no. 3). They describe and document the pharmaceutical activity controlled by Swissmedic.

Valpharmex manages customer complaints (SOP VPX no. 3) by using a standardized form common in the pharmaceutical distribution industry, which customers complete in the event of a dispute when they receive products in their warehouses and send to the company by email or post. Such disputes describe damaged, missing, or unordered products but can also relate to manufacturing defects. The forms are encoded into the system and searched for traceability data regarding the parcel or parcels addressed by the dispute. Each parcel has a unique number that allows information about the products—production batch number, expiration date, quantity of units in the parcel, shipping date, and value of the parcel—to be located. Such data allow the production of accounting documents to correct invoices initially sent to customers, credit memos, or additional invoices as necessary. The process implies that better preventive control of statistically contentious products should reduce the rate of customer litigations. To that end, specific warnings to dispatchers (i.e., handlers) to perform more detailed control of precise topologies of products could be placed on the products.

Through interviews and immersions, we have defined four indicators, which provide information about the quality of service. These are the number of received and shipped parcels, the stress level of the employees, the work experience on each task as well as the overtime. We have decided to merge explicit and tacit indicators to have a better understanding of the situation. This also enables us to determine Ansoff’s weak signals through the perception of the manager.

In this paper, only one indicator, the work experience, is developed and integrated in a feedforward control. It is presented in the following part of the text.

Valpharmex can determine what happens at given times in the supply chain. More practically, it can calculate the quantity of experience present on each task, during the various stages of the supply chain.

A person with more versatility will perceive mistakes from previous stages and be able to correct them. Accordingly, when for various reasons (e.g., illness, absence, and holidays) the degree of experience decreases, some measures can be taken to maintain a certain standard in the quality of service.

Such knowledge can be used to optimally plan the repartition of those employees in the different steps of the supply chain. With the goal of identifying the best allocation of employees according to their aptitude, the primary anticipatory measure is to assign employees with the most experience to sensitive stages of product traceability. Since those employees have more experience, they typically perform normally the tasks better, which can offer an advantage when employees are under pressure due to above-average workloads or high stress and fatigue. With that preventive measure in place, fewer errors should occur under the set conditions, and a certain quality of service can be assured.

However, such action is a preventive measure only in certain conditions. Although this can be absurd since we argue that fewer mistakes will likely be committed, it seems important to note that employees have different capacities to perform various tasks. Task variety can affect work satisfaction as well, which ultimately influences employee turnover. Moreover, task variety precludes dependence on the idea that only one person has a particular skill for a specific step, meaning that risk in case of employee absence can be lowered if one or more people can do the same job. For that reason, we propose that when activity is below average, training should be organized for employees with the goal of cultivating proper know-how for each task to be performed in the supply chain. To that end, an employee with more experience could explain the procedure to other workers involved in performing the task. We can at this point formalize the feedforward control based on weak signal according to Figure 3.

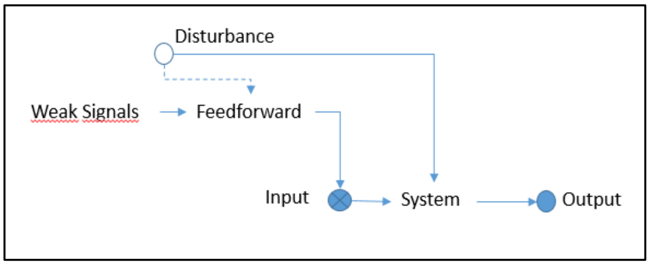

Figure 3. Adapted feedforward control fed by weak signals

A feedforward control is usually considered to be a three-step process:

1. Determining a business objective (e.g., keeping the number of customer complaints below the last year number);

2. Using an indicator anticipating whether the business objective will be reached in a timely manner. In our case the indicator is based on a weak signal (e.g. there is sufficient or there is not sufficient employee versatility regarding overall work loading);

3. Correcting the business process, if necessary, triggering the adequate "mitigation" according to the level of the anticipatory indicator (e.g., experienced employees are assigned to critical tasks as an immediate action, and in quieter times all employees are assigned to different tasks in order to become more versatile on the long haul).

VI. CONCLUSION

Pharmaceutical distribution involves specific supply chains whose chief risks are counterfeiting, diversion, cargo theft, and the importation of unapproved medicine. A way to mitigate such risks is to implement feedforward controls instead of more conventional feedback controls. Feedforward controls, also known as advanced controls or predictive controls, are expected to afford measures to prevent problems from occurring as long as predictions are consistent with the program of activities [35].

To properly forecast the achievement of business objectives, we applied the notion of weak signals, which indicate that a risk is deteriorating or increasing and thus that the probability of achieving the objective in due time is respectively reduced or heightened. If the level of risk deterioration becomes critical, then managers will be alerted to appraise the situation and, depending on its criticality, implement mitigation strategies. Of course, the difficulty of anticipating the achievement of business objectives is that indicators are usually qualitative and related to human factors.

Based on an in-depth exploratory case study involving semidirected interviews and immersion episodes, we designed and implemented a feedforward control in a Swiss wholesale distributor of pharmaceutical drugs. The feedforward control is fed by a weak signal showing that when employees assigned to perform tasks are less versatile, more errors occur. The control has since been integrated in the company's SOP for managing customer complaints in order to improve the overall quality of service. For now, we will monitor the performance of the implemented control and draw conclusions regarding its efficiency in order to improve it. We also intent to apply this feedforward based on weak signals for the service sector [36, 37] and, also for corporate government issues [38].

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