The dynamics of organizational problem-solving: A dual-process approach

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Abstract

This study investigates two distinct behavior modes with which organizations respond to operational problems: intuitive and analytical problem-solving (IPS and APS). From a cognitive perspective, the former is based on heuristic reasoning to eliminate problem symptoms whereas the latter relies on structured reasoning to diagnose and alter underlying causes. Although the effectiveness of APS is well-established, problem-solvers are often adopting IPS, a phenomenon called IPS dominance. Motivated by field-work at a manufacturing plant, we develop a simulation model to capture the development paths of two modes and the transition dynamics between them, to address the major reasons of IPS dominance.

Keywords: Problem-Solving, Dual-Process Theory, System Dynamics

Introduction

Problem-solving is considered as an important capability of firms to quickly respond to changes and to seek continuous improvement opportunities (Astor et al., 2016; Choo et al., 2015; Koskinen, 2012; Tucker et al., 2002; Mac Duffie, 1997; Garvin, 1993). Individuals as problem-solving entities learn from problems and failures if they are successfully overcome. However, there is a considerable consensus among researchers that not every problem-solving activity leads to sustainable organizational success (Choo

et al., 2015; Morrison, 2015; Repenning & Sterman, 2002; Tucker et al., 2002; Argyris, 1976).

In this study, we define problem-solving as the patterns of behavior developed to solve a problem and in line with the literature, we make a clear distinction between either fixing the problem by just removing its symptoms or overcoming it through diagnosing and altering underlying causes. Based on dual-process theory (Evans & Stanovich, 2013), one behavior mode employs intuitive, heuristic reasoning whereby problem-solvers use short-term remedies and prompt fixes to temporarily solve the problem. The second behavior mode relies on analytical reasoning to solve the problem fundamentally by the help of structured corrective actions. We label them as intuitive problem-solving (IPS) and analytical problem-solving (APS) respectively.

The aim of this study is twofold. First, to scrutinize IPS and APS by discussing the micro-foundations of each. Second, to explore when and under what circumstances one behavior mode is preferred over the other. More specifically, although the effectiveness of APS to guarantee sustainable success is well-established in the literature (i.e. resulting in a lower probability of re-appearance of the problem, contribution to strategic capabilities through detection and constant error correction, and consequently the amelioration of firm performance), problem-solvers are more likely to adopt IPS, a phenomenon which is called *IPS dominance* (Baer et al., 2013; Repenning & Sterman, 2002; Tucker et al., 2002). Therefore, this study also investigates the major reasons that reinforce the likelihood of IPS adoption as well as the factors to hinder APS in organizational problem-solving.

In order to understand the causes and circumstances of problem-solving activities in companies, we conducted a case-study. Based on insights from the studied company, IPS and APS are clarified by explicating the causal structure of each. We propose the main components and develop their relationships with barriers and enablers of each behavior mode in form of causal diagrams. Then, the causal diagrams, representing IPS and APS, are translated into formal simulation models following the system dynamics method (Sterman, 2000). Simulating IPS and APS separately assists to gain an enriched understanding regarding their dynamic behavior. However, we also propose an integrated model which links IPS and APS to gain a more comprehensive picture of organizational problem-solving. The integrated model, whose simulation captures the transition dynamics between two modes, sheds light on the higher tendency to pursue IPS as a favorable behavior mode. Based on simulation results, we address IPS dominance and highlight two main reasons for this phenomenon. The first one is high problem urgency which forces problem-solvers to work around the problem without adequate analysis. This is the case when individuals do not have sufficient time for APS due to time pressure. The second one, related to the characteristics of senior executives, is defined as managers with short-term horizon who emphasize immediate success rather than sustained development. In this case, managerial interventions for APS (i.e. allocating resources and supporting collaboration) are insufficient and as a consequence the analytical reasoning mode of problem-solvers is restrained with IPS dominating.

This paper, unlike many other efforts in this field, is not about presenting novel tools and techniques to support problem-solving. Instead, drawn from dual-process theory, we study two cognitive approaches for operational problems in an integrated model that simultaneously captures the dynamics of the two problem-solving modes in separation as well as the transition dynamics between the two modes. We believe that this study also provides insightful information for managers and practitioners to understand when and

under what circumstances IPS and APS perform effectively. This, indeed, could enable senior executives to design appropriate problem-solving strategies and relevant policies to cope with problems.

Research Methodology

Problem-solving is a dynamic process which could be very complex in terms of structure, feedback loops, and information (Sterman, 2000). We conducted a case-study to understand the proximal causes and circumstances of problem-solving activities in the real world. The research site was a manufacturing plant of gardening equipment and supplier of agricultural products. In this setting, operational problems—mainly related to cost, quality and delivery of the products—occur frequently (such as a high product defect rate or machine failures) and consequently we could observe problem-solving efforts (Morrison, 2015; Repenning & Sterman, 2002; Mac Duffie, 1997). We gathered data, over a period of three months, on the actual problem situation and investigated the ways that problems were dealt with. This included several days shadowing the managers and roaming the shop-floor employees as well as conducting semi-structured interviews to understand how problems are overcome in the case company. Various individuals engaged in problem-solving activities (e.g. general manager, production supervisor, and front-line employees) were interviewed, ranging from 10 minutes to 2 hours. Respondents were asked to provide information regarding the most substantial problems, and the way they approach and respond to the problems. Furthermore, we also relied on the memory of interviewees to provide historical information concerning different problems, their frequency, and the actions they took to solve them.

Data analysis began with reviewing the observational data and analyzing the notes recorded during the interviews. According to a problem-solver's attitude, we identified a sample of problems that were resolved either temporarily employing IPS or fundamentally adopting APS. We highlighted the characteristics of IPS and APS and determined the key variables and the causal links among them. Based on this coding, we made frequent sketches for these potential behavior modes. These graphical representations resulted in causal diagrams for IPS and APS (Morrison, 2015; Tucker & Edmondson, 2003). To ensure having a comprehensive understanding of problem-solving activities in the company and sharpen its generalizability, we double-checked the proposed structure and the links to see whether, or not, they are supported by the literature (Eisenhardt, 1989).

Explication of Building Blocks

Intuitive Problem-Solving

From a cognitive perspective, IPS is based on intuitive reasoning whereby problem-solvers employ short-term remedies and prompt fixes to temporarily solve the problem. Problem-solvers tend to follow this behavior mode by focusing more on the solution rather than the problem. Smith (1989) addresses this behavior mode as "people often design solution alternatives without having carefully diagnosed the problem's causes" (p. 967). In other words, problem-solvers jump to the solution where the intermediate steps of a structured problem-solving behavior such as problem definition, problem analysis, and solution implementation are usually skipped, abbreviated or implemented simultaneously. Based on insights from the case-study and in line with the literature, in Figure 1, we show the causal loop diagram that explicates the causal relationships among the key variables in IPS.

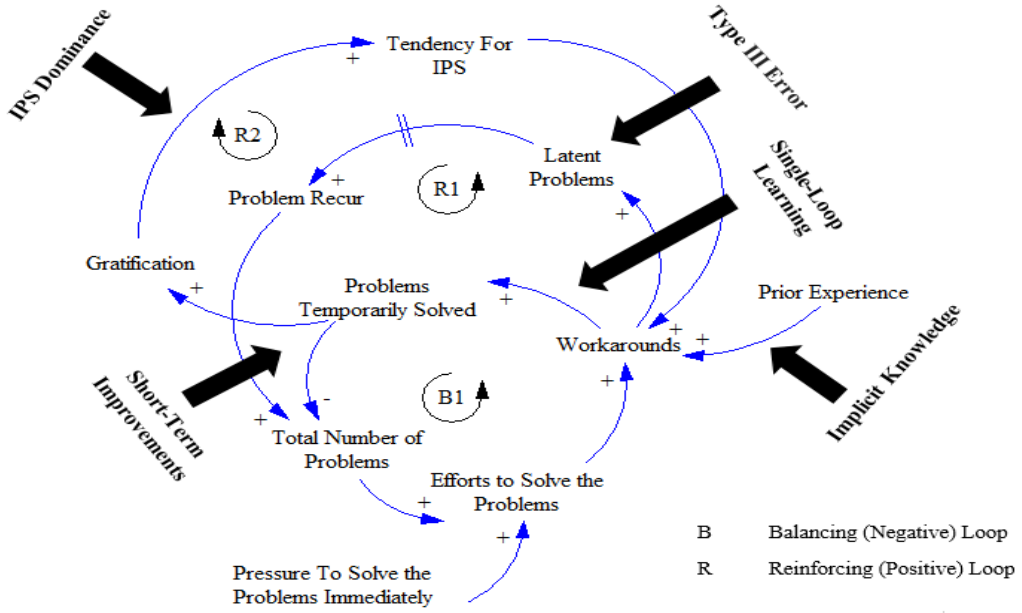

Figure 1- IPS Causal Loop Diagram

In general, a problem is defined as a deviation from the desired outcome (Baer et al., 2013; Smith, 1988). Problem initiation calls attention and triggers a set of actions to overcome the problem. However, *efforts to solve the problems* is determined by the *total number of problems* in the system and *pressure to solve the problems immediately*. Morrison (2015) and Repenning & Sterman (2002) characterize IPS as a way to increase pressure on front-line employees to meet the production target without realizing where the production deficit originates from. In a similar vein, it is quite common to hear from top managers that "don't bring me problems, bring me solutions" (Frei, 2007, p. 3). This also imposes additional pressure on problem-solvers to resolve the problems immediately. In order to alleviate this pressure, front-line employees devise *workarounds* (i.e. short-term remedies and prompt fixes) as the most satisfactory solutions. To proceed, problem-solvers rely only on their *prior experience* and existing hypotheses as Evans and Stanovich (2013) highlight implicit knowledge that is not articulated and codified through collective discussions and debriefing sessions for problem-solving (Zollo & Winter, 2002). Drawing on organizational learning literature, Argyris (1976) calls this behavior mode as "single-loop" learning where problem-solvers act as satisfiers by just removing the problem symptoms while the root-causes are neglected. IPS eventually results in short-term or incremental improvements (Choo et al., 2015; Repenning & Sterman, 2002; Tucker et al., 2002) as *problems temporarily solved.* This forms a balancing loop (*B1*) to counteract the change. For instance, the more problems solved temporarily from increasing workarounds, the less problems remain in the system.

IPS, although effective to temporarily solve the problem, might create some negative consequences. More precisely, since an inadequate emphasis is placed on understanding and eliminating the major causes of the problem, there is a very high likelihood for the problem to recur. The reason is that problem symptoms disappear temporarily because of IPS adoption while the real problem stays uncovered (i.e. *latent problem*). Problem symptoms re-appear with a *delay* as latent problems become visible again. This reinforcing loop, labeled *R1*, shows that an increased use of *workarounds* causes *latent problems* to increase and *total number of problems* to grow. Once attempts are only made

to eliminate the symptoms, error type III or solving a wrong problem is likely to occur (Lyles, 2014; Smith, 1989; Volkema, 1986). Additionally, when a problem is solved, it brings *gratification* and self-confidence for problem-solvers (Tucker & Edmondson, 2003). This could be further supported in our studied case when a front-line employee stresses that "I prefer to solve my problems on my own without reporting them to my supervisor to avoid being blamed by him". Therefore, problem-solvers appear to show a higher *tendency for IPS*, the phenomenon that is called IPS dominance. IPS dominance creates an additional willingness to employ *workarounds* for other potential problems without considering the negative consequences. This forms another reinforcing loop: the more problems temporarily solved, the higher the level of gratification for problem-solvers and, thus, a higher tendency for IPS adoption that leads to an increasing number of workarounds (*R2*).

Analytical Problem-Solving

According to the definition, APS is based on analytical reasoning in order to fundamentally solve the problem with the help of structured corrective actions. This deliberate and reflective efforts assume a logical and step-wise process to link the observed problem to a diagnosis, and eventually an appropriate solution through a systematic search process (Astor et al., 2016). Problem analysis, in particular root-cause investigation, plays a substantial role in this behavior mode. Figure 2 displays the causal loop diagram for APS, representing the major parameters, polarities of causal relationships and feedback loops.

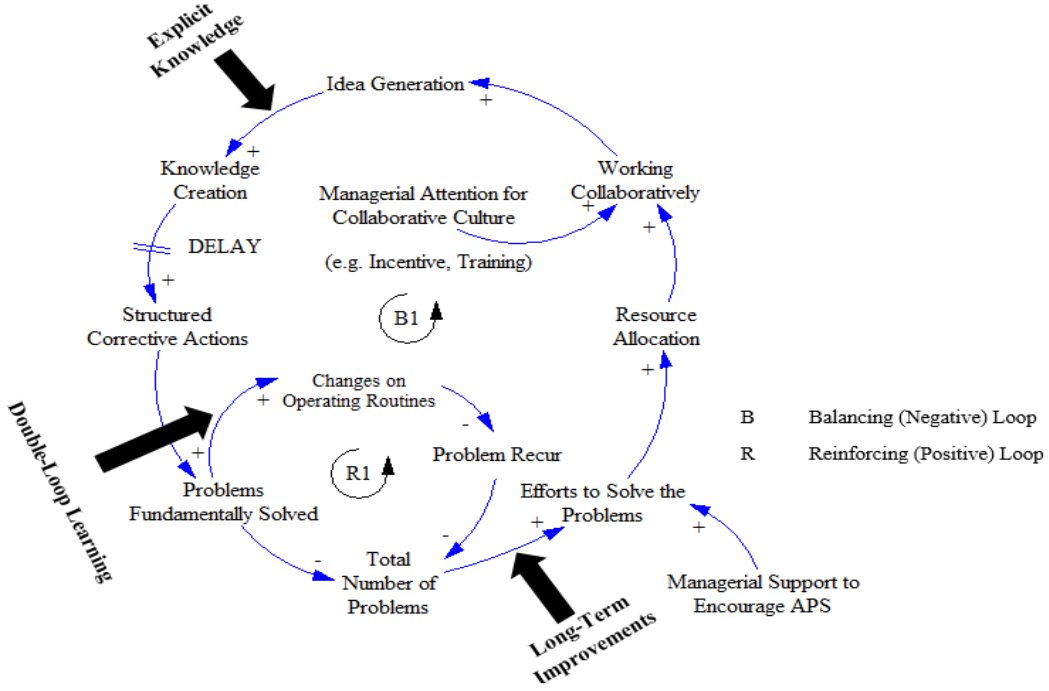

Figure 2- APS Causal Loop Diagram

To fully take advantages of APS, problems should be comprehensively formulated. In APS, as opposed to IPS that is characterized by the pressure to react immediately to problems, senior executives encourage APS to fundamentally solve problems. The balancing feedback loop (*B1*) is driven by effective *resource allocation* and *working collaboratively* as a result. However, collaboration is determined by *front-line employees*

assigned to work in a team and *managerial attention* to spread a collaborative culture along the teams. This could be done through making incentives or training people. Group problem-solving with a high collaboration rate among members seems essential for this behavior mode in order to gather valid information regarding the problem structure (i.e. main problem and its root-causes). For instance, Morrison (2015) prescribes working collaboratively with higher employee participation to respond properly to the resource shortage problem and increase the productivity accordingly. In other words, when a problem is viewed from various perspectives provided by different team members with diverse cognitive structures in brainstorming sessions, more *ideas* are generated regarding how to structure the problem (Baer et al., 2013). As a consequence, APS creates and retains *explicit knowledge* (Evans & Stanovich, 2013; Zollo & Winter, 2002) useful for *structured corrective actions*. In this regard, problem-solvers view problems as opportunities to learn rather than just liabilities to avoid (Mac Duffie, 1997). This way of responding to the problems is called double-loop learning where problem-solvers diagnose and alter the identified problem causes (Argyris, 1976). A successful adoption of APS is likely to result in positive *changes* in operating routines (Itabashi-Campbell et al., 2011). This reduces the likelihood of *problem recur* and leads to long-term improvements eventually (Choo et al., 2015; Repenning & Sterman, 2002; Tucker et al., 2002) as problems are fundamentally solved. *R1* represents a reinforcing loop in which the more *problems fundamentally solved*, the more positive *changes on operating routines* of the firm that eventually cause *problem recur* to decrease and *total number of problems* to decline. However, APS becomes effective only with a *delay* as Repenning & Sterman (2002) characterize it as an improvement-based behavior whose outcome is not paid off immediately.

Simulation and Analytical Results

Figures 3.1 and 3.2 demonstrate the behavior of the total number of problems remaining in the system as the results of simulating the formal system dynamics models for IPS and APS respectively. These system dynamics models are based on the causal diagrams depicted in Figures 1 and 2. We discuss the performance of each behavior mode as their capacity to solve the problems remaining in the system. Hence, the performance of each is based on a premise that the lower number of problems, the better performance.

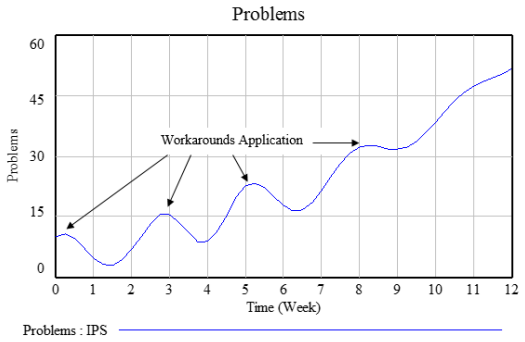

Figure 3.1- Total Number of Problems using IPS

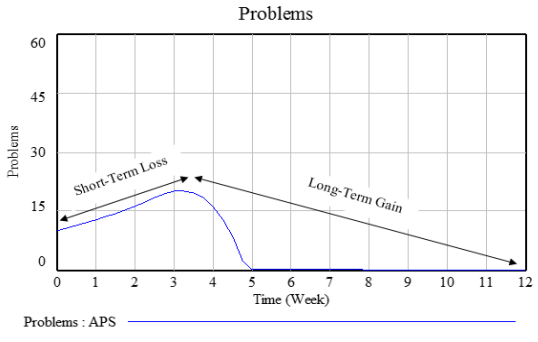

Figure 3.2- Total Number of Problems using APS

As depicted in figure 3.1, the use of workarounds reduces the total number of problems in the short-term. Indeed, once IPS is adopted and quick fixes and prompt remedies are employed, the total number of problems decreases in a few weeks after the workarounds'

application. The reason is that, when there is high pressure to react, IPS enables problem-solvers to solve the problem temporarily by alleviating the problem symptoms. So, in line with the literature, we conclude that IPS betters the short-term performance of the firm (Morrison, 2015; Repenning & Sterman, 2002; Tucker et al., 2002). However, workarounds, although helpful to control the situation and prevent it from getting worse, often fail to address the real problem. Therefore, hidden causes of temporarily-solved problems become visible again and problems recur as Figure 3.1 illustrates an increasing trend of problems in long-term.

As discussed earlier, APS suggests structured actions to successfully cope with the problems. However, APS does not pay off immediately (Repenning & Sterman, 2002). The reason is that when a problem is initiated, attempts should be made to understand the problem structure. This phase, called short-term loss, occurs where problems are still in the system while problem-solving team attempts to discover the causes as well as the best solution to take. Once the problem is comprehensively formulated and the root-causes are identified, problem-solvers take the structured actions to fundamentally solve the problem. This phase is called long-term gains (Longenecker et al., 1994). The trend of overshoot and collapse is depicted in figure 3.2.

To have a more comprehensive picture of organizational problem-solving and a better comparison between IPS and APS, we propose an integrated model by linking these behavior modes. In order to simulate different situations and consequently to set effective problem-solving strategies, we define two scenario variables. The first one, P1, is time pressure to solve the problems immediately that results in quick reactions (Repenning & Sterman, 2002; Tucker et al., 2002). The second one, P2, is managerial intervention to allocate resources and support collaboration to encourage APS and fundamental solutions accordingly (Morrison, 2015). As a result, four different scenarios should be investigated where P1 and P2 could be either high or low (Figure 4).

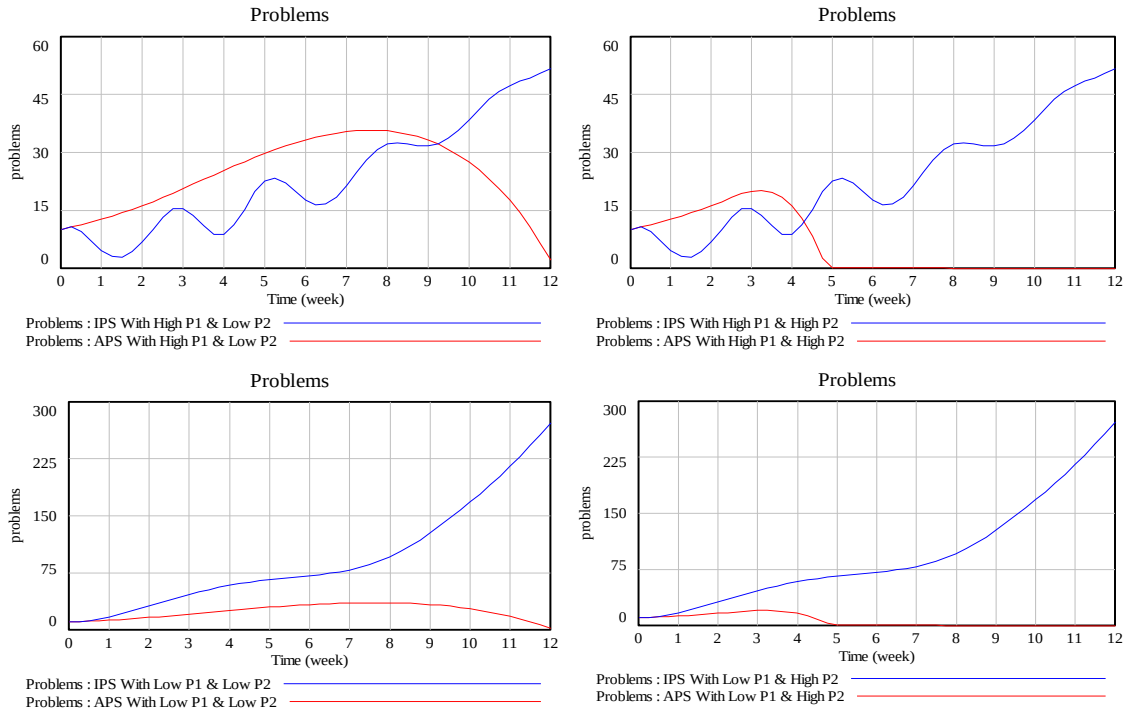

Figure 4- IPS vs. APS in four scenarios

Simulation results reveal that IPS always outperforms APS in the short-term when there is high problem urgency. However, in the long run, APS has a better performance in terms of the total number of problems remaining in the system. The reason is that APS becomes effective with a delay only. Hence, managers with the short-term horizon, who care most about immediate success, prefer IPS whereas managers with a long-term horizon, with more attention to sustainable success and growth, emphasize APS.

Table 1- Summary of Results of Scenarios Defined

Scenario Variables	Low Managerial Intervention	High Managerial Intervention
High Time Pressure	IPS in Short-Term & APS in Long-Term	IPS in Short-Term & APS in Long-Term
Low Time Pressure	APS	APS

In short, high problem urgency and managers with short-term horizon emerge as two major reasons for IPS dominance as well as the factors to hinder APS in organizational problem-solving (Table 2).

Table 2- IPS Dominance Reasons

Scenario Variables	Definition	Reasons for IPS Dominance
P1	Time Pressure	High Problem Urgency
P2	Managerial Intervention	Managers with Short-Term Horizon

However, it is also possible to interpret the results from another perspective. IPS should be preferred when problem urgency is extremely high (e.g. crisis). In other words, where the sense of urgency overtakes the need for problem formulation comprehensiveness, IPS can be adopted to control the situation from getting worse and keep operations running although only in a suboptimal way.

In all previous cases, we assumed that problems-solvers adopt only either IPS or APS. However, the proposed integrated model provides the opportunity to simulate a case in which top managers consider both behavior modes simultaneously. In this setting, IPS and APS are not totally ignored. Instead, they might adopt IPS to keep the production running and APS, simultaneously, to completely solve the problems. To do so, we test various resource allocation mechanisms by simulating the integrated model with different portions of resources for IPS and APS (Figure 5). For instance, the red line represents the situation in which a higher percentage of resources (in this case 70 %) is assigned for IPS to take immediate corrective actions. In this case, IPS carries more weight from a top manager's point of view either because of problem urgency or their short-term horizon.

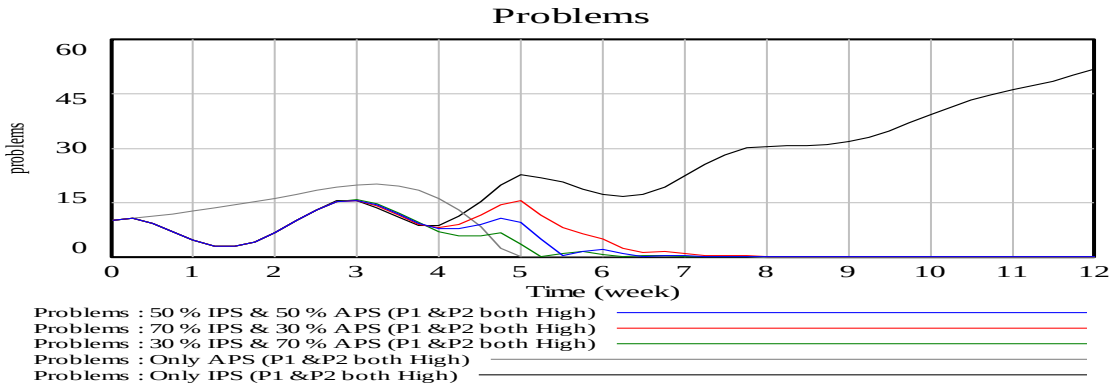

Figure 5- IPS and APS with Different Resource Allocation Mechanisms

Simulation results suggest that the best problem-solving strategy to take could be a combination of IPS and APS. The green line, the situation in which 30 % of front-line employees are engaged in IPS to solve the problems temporarily and 70 % of resources are allocated to work in a team for APS, represents in our example the best strategy considering the total number of problems remaining in both short-term and long-term.

Discussion and Conclusion

The focus point of this study is to compare two distinct problem-solving behavior modes, adopting a cognitive perspective. Based on dual-process theory, we thoroughly study IPS and APS and establish the micro-foundations of each. Motivated by fieldwork in a manufacturing plant, we propose the structure of IPS and APS by unpacking them. Along with observational data, literature supports IPS as the favored behavior mode, even though the effectiveness of APS is well-supported. This study is an attempt to explore the major reasons of IPS dominance. Using system dynamics modeling and by the help of simulation analysis, we identify two main reasons for this phenomenon that also could be recognized as the main impediments for APS adoption in organizational problem-solving. The first one is problem urgency emerging from time pressure to react quickly to the problems. Indeed, problem-solvers are more likely to adopt IPS when the sense of urgency overtakes problem formulation comprehensiveness. This pressure, either an internal pressure from top managers to solve the problems as soon as possible or external one due to harsh environmental dynamism (e.g. intense competition or sudden changes in customer demands), makes problem-solvers act as quick satisfiers and jump to solutions without sufficient consideration of the current situation. The second one is recognized as managers with a short-term horizon who care most about immediate success rather than sustainable development of the firm. In this case, top managers focus massively on prompt remedies while less attention is placed on long-term consequences of decisions.

We also believe that this study provides relevant information for managers and practitioners to realize when and under what circumstances they should adopt IPS or APS to gain the most from each behavior mode. In other words, we propose a helpful guideline for managers to set different problem-solving strategies and relevant policies in different situations, for instance, when problem urgency is extremely high.

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