The Shifting the Burden Archetype: A Workforce and Task Backlog Management Game

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Abstract

We first develop a workforce and task backlog management model based on the shifting the burden archetype. The model involves the corresponding solution archetype in addition to the problem archetype. Secondly, we develop a game based on the model. Finally, we present an experimental design in this paper. We plan to randomly assign the participants into three separate test groups. The first group will be guided towards the problem archetype. The second group will be guided towards the solution archetype. The third group will be guided towards a balanced approach that consists of both the problem and solution archetypes. We expect that the participants who will be guided towards using the solution archetype will improve their performances while the participants who will be guided towards using the problem archetype will have a deterioration in their performances. In a follow-up paper, we plan to summarize the results that will be obtained from the experiment. The motivation for this study is to demonstrate the long term benefits of systems thinking and system dynamics in decision making. We hope that such a demonstration will promote systems thinking and system dynamics and increase the willingness of the decision makers in applying high leverage policies.

Keywords: Decision making game; problem archetype; shifting the burden; solution archetype; systems archetypes; systems thinking; task backlog; workforce management.

1. Introduction

System dynamics (SD) is a simulation based approach for modeling, analyzing, and improving complex dynamic systems consisting of accumulation processes, feedback loops, delays, and nonlinear relationships (Barlas, 2002; Barlas and Yasarcan, 2006; Forrester, 1961; Sterman, 2000; Yasarcan, 2010 and 2011). Jay W. Forrester established SD towards end of 1950's. After that, many books had been written describing models that are constructed using the SD methodology. Some of these publications such as *Industrial Dynamics, Urban Dynamics,* and *World Dynamics* attracted the attention of academia and business world in the 1970's. *Limits to Growth* (1972) is another book that describes an SD model and discusses its dynamics. The book is about economic and population growth of the world under finite resources. It created a strong debate and became the subject of many studies. As a result of the continuing attention on the issue, the updated versions of the book are published several times, the last one being in 2004.

Systems Thinking (ST) became popular after the publication of Peter Senge's bestseller book, *The Fifth Discipline: The Art and Practice of the Learning Organization*, in 1990 (Papucar-Caceres A., 2008; William D. Miller, 2012). Both ST and SD aim to address complex systemic dynamic feedback problems. The main difference between the two is that the product of an ST study is a conceptual model; however, the product of an SD study is an operational simulation model that is analyzed mostly numerically and sometimes analytically (Sterman, 2002). Thus, ST overlaps only with the conceptual phase of SD (Forrester, 1994).

The span of applications of SD and ST includes Supply Chain Management, Project Management, Diffusion Processes, Commodity Cycles, and System Archetypes, but not limited by them.

System archetypes – balancing process with delay, limits to growth, shifting the burden, eroding goals, escalation, success to successful, tragedy of the commons, fixes that fail, and growth and underinvestment – aim to give insight to the managers about the existing dynamic problems in their organizations so that they can understand and solve those persistent problems that are systemic in nature (Senge, 1990). A system archetype encompasses both the problem archetype and the solution archetype of the related problem. The problem archetype involves the non-systemic solution to the problem that creates unintended consequences, whereas the solution archetype involves the systemic solution that aims to minimize the unintended consequences that appear in the long term (Senge, 1990; Wolstenholme, E.F, 2003; Wolstenholme, E.F, 2004).

Although SD has an extensive application area and there are many influential and highly cited publications resulting from SD studies, the field is perceived as stagnating (Forrester, 2007; Barlas, 2007). "*At present, with system dynamics on a rather aimless plateau, the field seems to be catching its breath. The field is pursuing practices of the last many decades, but there is little evidence of a strong reach into new territory.*" Forrester (2007). Some of the important factors that are listed by the experts as an explanation for the stagnation are lack of education, inadequate system dynamics tools, neglecting the importance of implementation phase of system dynamics projects, and lack of intense debate (Forrester,1994; Richardson 1996; Größler 2007).

Kim and Senge (1994) stated that the penetration of ST in main stream management practice is much lower than the recognition of "interdependency and change" (i.e., dynamic complexity) by managers. One of the reasons for the stagnation in and the low penetration of SD/ST can be explained by the reluctance of the decision makers in applying high leverage policies as they usually imply a worse before better results (Sterman, 2001).

It is suggested in the literature that knowing systems thinking and its conceptual tools such as system archetypes and casual loops give a framework to the decision maker. There are studies indicating that having a mental model of the underlying structure of a dynamic problem improves performances of the decision makers in dealing with that problem (Senge, 1990;). Some studies are based on teaching system dynamics. System archetypes were also taught as a part of one such training program (Schwaninger, 2003). However, no performance data was collected in those studies (Cavaleri and Sterman, 1997). Therefore, there is a gap in the literature.

Aiming to fill in the aforementioned gap, we first develop a workforce and task backlog management model based on the shifting the burden archetype. The model involves the corresponding solution archetype in addition to the problem archetype. Secondly, we develop a game based on the model. Finally, we present an experimental design in this paper. We plan to randomly assign the participants into three separate test groups. The first group will be guided towards the problem archetype. The second group will be guided towards the solution archetype. The third group will be guided towards a balanced approach that consists of both the problem and solution archetypes. We expect that the participants who will be guided towards using the solution archetype will improve their performances while the participants who will be guided towards using the problem archetype will have a deterioration in their performances. In a follow-up paper, we plan to summarize the results that will be obtained from the experiment. The motivation for this study is to demonstrate the long term benefits of systems thinking and system dynamics in decision making. We hope that such a demonstration will promote systems thinking and system dynamics and increase the willingness of the decision makers in applying high leverage policies.

2. Workforce and Task Backlog Management Model

Kunsch et all. (2007) created quantitative SD models of real-life cases, which can be explained by Senge's archetypes. One of the selected archetypes is shifting the burden. In Kunsch et all.'s business case, there is a company aiming to meet the demand of their customers (see Figure 4 in Kunsch et all., 2007). A decision maker can take two actions in order to satisfy the customer demand: "hiring external experts" or "training experts". Hiring external experts is quick, but it is comparatively more expensive. The other option, training experts, takes time, but it is comparatively cheaper. In this model, hiring external experts activates the feedback loop for the problem archetype as it represents the short term solution; on the other hand, training experts activates the feedback loop for the solution archetype as it represents the long term systemic solution. Inspired by Kunsch et all.'s case, we constructed a detailed model of workforce and task backlog management. There are four main sub-structures of the model: Task completion structure; internal expert structure; external structure; and cost structure. These structures are explained in the following sub-sections and the corresponding equations are given in the appendix.

2.1. Task Completion Structure

Capacity in regard to internal experts is called as internal processing capacity whereas capacity in regard to external experts is called as external processing capacity. Note that our model is a discrete time model. Hence, all variables are updated every simulated week. Tasks arrive weekly; we assume tasks are normally distributed with a mean of 1000 and a variance of 40,000. If the task arrival rate is greater than total processing capacity, backlog level increases. On the other hand, if the total processing capacity is greater than the task arrival rate, backlog level decreases. Note that backlog level cannot be less than zero. Accordingly, if backlog is zero and the total processing capacity is greater than the task arrival rate, idle capacity occurs. Task completion structure is presented in Figure 1.

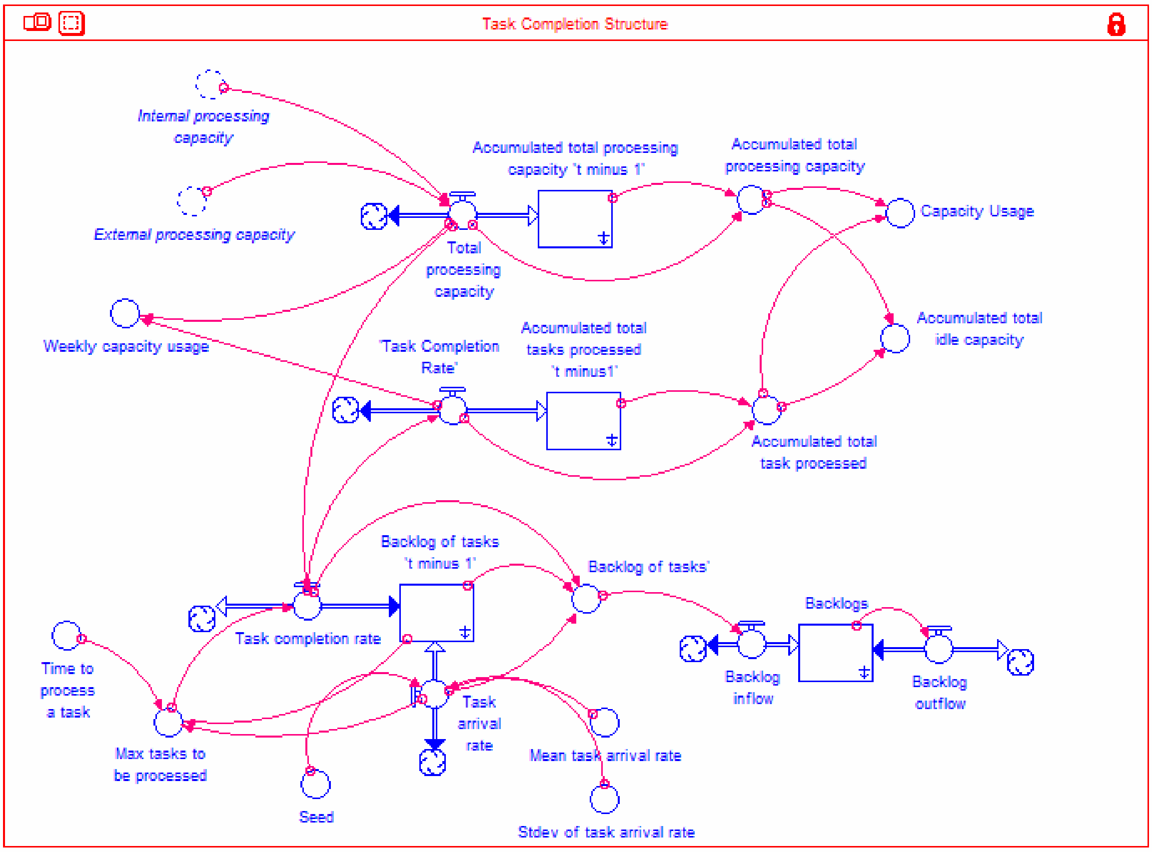

Figure 1. Task Completion Structure

2.2. Internal Expert Structure

Trainee Hiring Decisions is one of the three variables controlled by the decision maker (i.e., participant). Trainees joins the workforce (i.e., enter Internal Experts stock) after completing a four week training program. Trainees are required to get a ten hour one-to-one training from the internal experts each week for four weeks. Internal experts work 40 hours per week. However, they can dedicate at most half of their weekly working hours (i.e., 20 hours) for one-to-one training. Thus, each internal expert can at most train 2 trainees per week. If the trainees are more than two times of the internal experts, they need to wait in the corresponding trainee stock until they receive the required training. The trainees that are in the fourth week of the training program have priority in receiving the required training. In other words, internal experts first train the trainee who is closer to become an internal expert, and train the others if there is enough time left.

Internal Expert Firing Decision is another variable controlled by the decision maker. There is a cost of firing an internal expert. Internal experts may choose to quit themselves, but they are not paid in that case. Note that we assume there is a special agreement between the trainees and the company. According to this bi-directional (reciprocal) agreement, trainees cannot be fired and they cannot quit.

Internal expert structure is presented in the Figure 2.

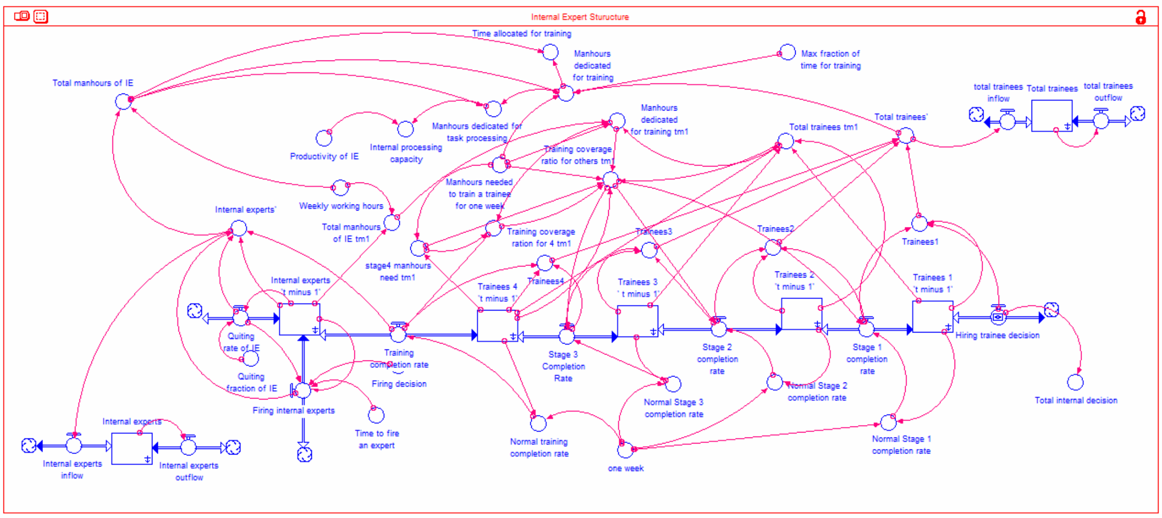

Figure 2. Internal Expert Structure

2.3. External Expert Structure

External Expert Hiring Decision is another variable controlled by the decision maker. Different than internal experts, an external expert is hired only one week. Accordingly, external experts are flushed out from the corresponding stock. External expert structure is presented in the Figure 3.

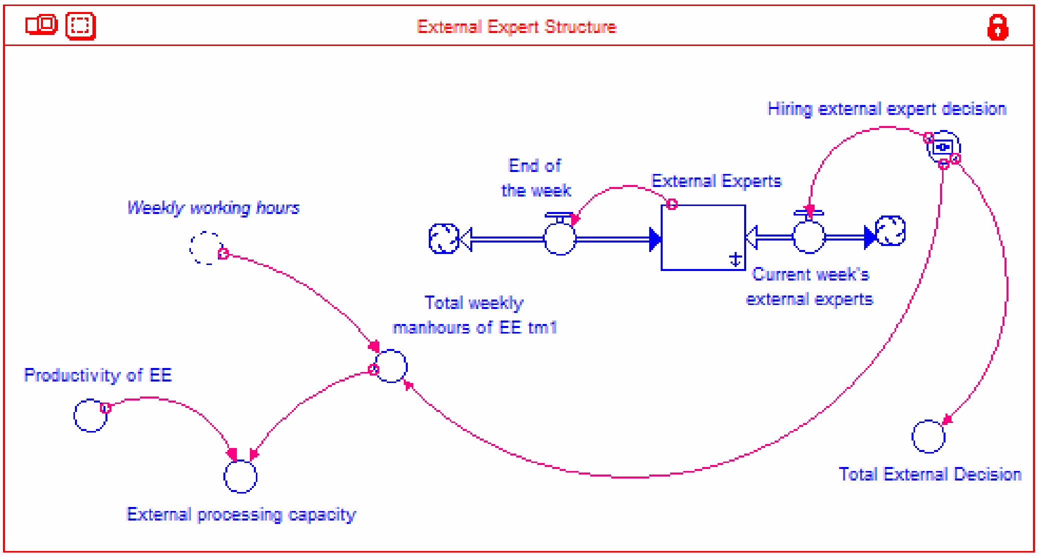

Figure 3. External Expert Structure

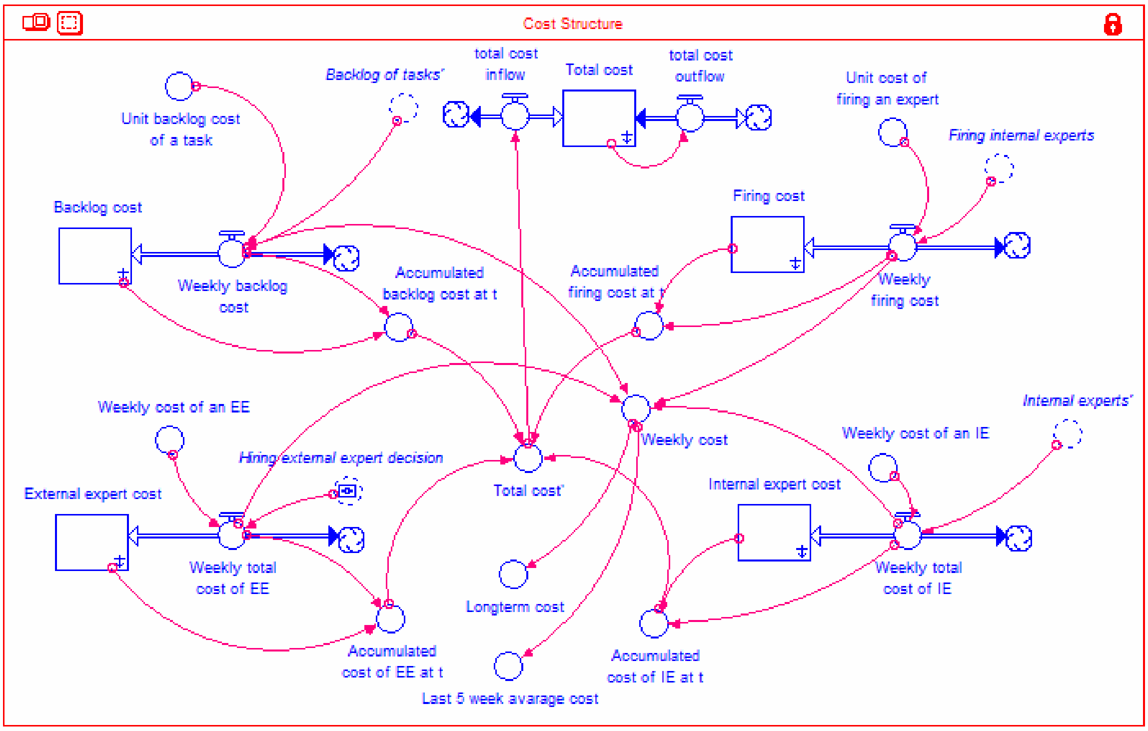

Figure 4. Cost Structure

2.4. Cost Structure

There are four cost items in the model. These are; backlog cost, internal expert cost, external expert cost, and firing cost. The cost structure of our model is presented in the Figure 4. Note that total cost is the main performance variable.

3. Workforce and Task Backlog Management Game

We developed a game based on the structure presented in the previous section. The decisions are entered either using sliders or by entering values. Current workforce levels, current task backlog levels, and accumulated and weekly costs are reported. The game lasts for 20 simulated weeks. The game surface is presented in Figure 5.

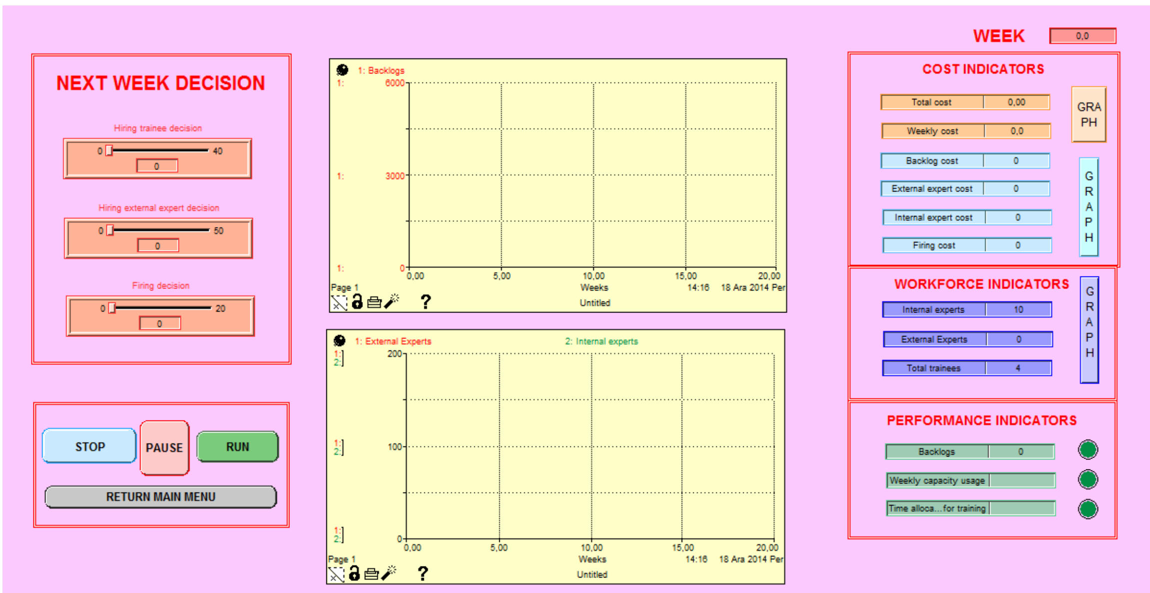

Figure 5. Game surface

4. Experimental Design

There are three treatment groups. Every group receives 4 games. The structure of the four games is exactly the same, but a different seed is used for each game to generate *Task Arrival Rate*. Thus, first, second, third, and fourth games slightly differ from each other, but they are essentially the same. Every treatment group plays the same exact game with the same exact seed. Thus, for example, game 3 of treatment group 1 and treatment group

3 is exactly the same. The only difference between the three groups is the hint that they receive before the last game. The aim of these hints is to guide participants either to the suggested solution archetype, to the problem archetype, or to a balanced version of these two archetypes. These hints are:

- There are different advantages and disadvantages of preferring internal experts or external experts. It takes at least 4 weeks to train an internal expert. Whereas, external experts are hired for the following week. Therefore, from the point of earliness in starting to work, using external experts is more beneficial. On the other hand, the cost of an internal expert is just one sixth of the cost of an external expert. Therefore, from the point of salary payments, using internal experts is more advantages. We suggest that internal and external experts should be used aiming to balance these two advantages. We expect you to play this last game in the light of this hint.
- Although, it seems that training an internal expert takes a long time, it provides significant advantages in decreasing costs in long term. After the trained internal experts join the service activities, they will help you save money by eliminating the need for the external experts. We expect you to play this last game in the light of this hint.
- Although, it seems that working with the external experts is costly, it is cheaper than hiring and training internal experts in the long term. During the four week training period, internal experts spend a significant amount of their time in training activities, which causes an increase in the backlog and, thus, backlog cost. Moreover, trainees do not contribute to the activities that reduce the backlog during their training period. Whereas, external experts are hired for the following week and by working full time in service activities, they prevent the accumulation of backlog. Besides, you hire external experts for only a week. Therefore, when backlog is very low, you are not supposed to bear unnecessary workforce costs. On the other hand, only a small fraction of internal experts quit each week. Thus, you are supposed to fire internal experts when it is necessary, which creates a total cost of four week salary of the fired internal experts. For these reasons, using external

experts is advantageous in the long term. We expect you to play this last game in the light of this hint.

5. Conclusions

In this study, we presented a workforce and task backlog management model and a game based on this model. We also described an experimental design. This paper presents a part of the study in which we aim to demonstrate the long term benefits of systems thinking and system dynamics in decision making. We hope that such a demonstration will promote systems thinking and system dynamics and increase the willingness of the decision makers in applying high leverage policies.

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Appendix: Model Equations

Accumulated_total_processing_capacity_'t_minus_1'(t) = Accumulated_total_processing_capacity_'t_minus_1'(t - dt) + (Total_processing_capacity) * dt
INIT Accumulated_total_processing_capacity_'t_minus_1' = 0

INFLOWS:
Total_processing_capacity = External_processing_capacity + Internal_processing_capacity

Accumulated_total_tasks_processed_'t_minus1'(t) = Accumulated_total_tasks_processed_'t_minus1'(t - dt) + ('Task_Completion_Rate') * dt
INIT Accumulated_total_tasks_processed_'t_minus1' = 0
INFLOWS:
'Task_Completion_Rate' = Task_completion_rate

Backlogs(t) = Backlogs(t - dt) + (Backlog_inflow - Backlog_outflow) * dt
INIT Backlogs = 0
INFLOWS:
Backlog_inflow = Backlog_of_tasks'
OUTFLOWS:
Backlog_outflow = Backlogs

Backlog_cost(t) = Backlog_cost(t - dt) + (Weekly_backlog_cost) * dt
INIT Backlog_cost = 0
INFLOWS:
Weekly_backlog_cost = Unit_backlog_cost_of_a_task*Backlog_of_tasks'

Backlog_of_tasks_'t_minus_1'(t) = Backlog_of_tasks_'t_minus_1'(t - dt) + (Task_arrival_rate - Task_completion_rate) * dt
INIT Backlog_of_tasks_'t_minus_1' = 0
INFLOWS:
Task_arrival_rate = MIN(2*Mean_task_arrival_rate,MAX(0,NORMAL(Mean_task_arrival_rate,Stdev_of_task_arrival_rate,Seed)))
OUTFLOWS:
Task_completion_rate = MIN(Max_tasks_to_be_processed, Total_processing_capacity)

External_Experts(t) = External_Experts(t - dt) + (Current_week's_external_experts - End_of_the_week) * dt
INIT External_Experts = 0
INFLOWS:
Current_week's_external_experts = Hiring_external_expert_decision
OUTFLOWS:
End_of_the_week = External_Experts

External_expert_cost(t) = External_expert_cost(t - dt) + (Weekly_total_cost_of_EE) * dt
INIT External_expert_cost = 0
INFLOWS:
Weekly_total_cost_of_EE = Weekly_cost_of_an_EE*Hiring_external_expert_decision

Fires_experts(t) = Fires_experts(t - dt) + (firing_rate_input - firing_rate_output) * dt
INIT Fires_experts = 0
INFLOWS:
firing_rate_input = Firing_internal_experts
OUTFLOWS:
firing_rate_output = Fires_experts

Firing_cost(t) = Firing_cost(t - dt) + (Weekly_firing_cost) * dt
INIT Firing_cost = 0
INFLOWS:
Weekly_firing_cost = Unit_cost_of_firing_an_expert*Firing_internal_experts

Internal_experts(t) = Internal_experts(t - dt) + (Internal_experts_inflow - Internal_experts_outflow) * dt
INIT Internal_experts = 10
INFLOWS:
Internal_experts_inflow = Internal_experts'
OUTFLOWS:
Internal_experts_outflow = Internal_experts

Internal_experts_'t_minus_1'(t) = Internal_experts_'t_minus_1'(t - dt) + (Training_completion_rate - Quiting_rate_of_IE - Firing_internal_experts) * dt
INIT Internal_experts_'t_minus_1' = 10
INFLOWS:
Training_completion_rate = Training_coverage_ration_for_4_tm1*Normal_training_completion_rate
OUTFLOWS:
Quiting_rate_of_IE = Quiting_fraction_of_IE*Internal_experts_'t_minus_1'
Firing_internal_experts = MIN(Firing_decision, Internal_experts_'t_minus_1'/Time_to_fire_an_expert - Quiting_rate_of_IE)

Internal_expert_cost(t) = Internal_expert_cost(t - dt) + (Weekly_total_cost_of_IE) * dt
INIT Internal_expert_cost = 0
INFLOWS:
Weekly_total_cost_of_IE = Weekly_cost_of_an_IE*Internal_experts'

Joining_the_workforce(t) = Joining_the_workforce(t - dt) + (Noname_2 - Noname_3) * dt
INIT Joining_the_workforce = 0
INFLOWS:
Noname_2 = Training_completion_rate
OUTFLOWS:
Noname_3 = Joining_the_workforce

Quited_experts(t) = Quited_experts(t - dt) + (quiting_rate_input - quiting_rate_output) * dt
INIT Quited_experts = 0

INFLOWS:
quiting_rate_input = Quiting_rate_of_IE
OUTFLOWS:
quiting_rate_output = Quited_experts
Report_for_week(t) = Report_for_week(t - dt) + (Report_for_week' - Flush_out) * dt
INIT Report_for_week = 0
INFLOWS:
Report_for_week' = Time+1
OUTFLOWS:
Flush_out = Report_for_week
Total_cost(t) = Total_cost(t - dt) + (total_cost_inflow - total_cost_outflow) * dt
INIT Total_cost = 0
INFLOWS:
total_cost_inflow = Total_cost'
OUTFLOWS:
total_cost_outflow = Total_cost
Total_trainees(t) = Total_trainees(t - dt) + (total_trainees_inflow - total_trainees_outflow) * dt
INIT Total_trainees = Trainees_1_'t_minus_1'+Trainees_2_'t_minus_1'+Trainees_3_'_t_minus_1'+Trainees_4_'t_minus_1'
INFLOWS:
total_trainees_inflow = Total_trainees'
OUTFLOWS:
total_trainees_outflow = Total_trainees
Trainees_1_'t_minus_1'(t) = Trainees_1_'t_minus_1'(t - dt) + (Hiring_trainee_decision - Stage_1_completion_rate) * dt
INIT Trainees_1_'t_minus_1' = 1
INFLOWS:
Hiring_trainee_decision = 0
OUTFLOWS:
Stage_1_completion_rate = Training_coverage_ratio_for_others_tm1*Normal_Stage_1_completion_rate
Trainees_2_'t_minus_1'(t) = Trainees_2_'t_minus_1'(t - dt) + (Stage_1_completion_rate - Stage_2_completion_rate) * dt
INIT Trainees_2_'t_minus_1' = 1
INFLOWS:
Stage_1_completion_rate = Training_coverage_ratio_for_others_tm1*Normal_Stage_1_completion_rate
OUTFLOWS:
Stage_2_completion_rate = Training_coverage_ratio_for_others_tm1*Normal_Stage_2_completion_rate
Trainees_3_'_t_minus_1'(t) = Trainees_3_'_t_minus_1'(t - dt) + (Stage_2_completion_rate - Stage_3_Completion_Rate) * dt
INIT Trainees_3_'_t_minus_1' = 1
INFLOWS:
Stage_2_completion_rate = Training_coverage_ratio_for_others_tm1*Normal_Stage_2_completion_rate
OUTFLOWS:
Stage_3_Completion_Rate = Training_coverage_ratio_for_others_tm1*Normal_Stage_3_completion_rate
Trainees_4_'t_minus_1'(t) = Trainees_4_'t_minus_1'(t - dt) + (Stage_3_Completion_Rate - Training_completion_rate) * dt
INIT Trainees_4_'t_minus_1' = 1
INFLOWS:
Stage_3_Completion_Rate = Training_coverage_ratio_for_others_tm1*Normal_Stage_3_completion_rate
OUTFLOWS:
Training_completion_rate = Training_coverage_ration_for_4_tm1*Normal_training_completion_rate
Accumulated_backlog_cost_at_t = Weekly_backlog_cost+Backlog_cost
Accumulated_cost_of_EE_at_t = External_expert_cost+Weekly_total_cost_of_EE
Accumulated_firing_cost_at_t = Weekly_firing_cost+Firing_cost
Accumulated_total_idle_capacity = Accumulated_total_processing_capacity-Accumulated_total_task_processed
Accumulated_total_processing_capacity = Accumulated_total_processing_capacity_'t_minus_1'+Total_processing_capacity
Accumulated_total_task_processed = Accumulated_total_tasks_processed_'t_minus1'+'Task_Completion_Rate'
Accumulated__cost_of_IE_at_t = Weekly_total_cost_of_IE+Internal_expert_cost
Backlog_of_tasks' = Backlog_of_tasks_'t_minus_1'+Task_arrival_rate-Task_completion_rate
Capacity_Usage = IF (Accumulated_total_processing_capacity= 0)
THEN 0
ELSE Accumulated_total_task_processed/Accumulated_total_processing_capacity
External_processing_capacity = Productivity_of_EE*Total_weekly_manhours_of_EE_tm1
Firing_decision = 0
Hiring_external_expert_decision = 0
Internal_experts' = Internal_experts_'t_minus_1'+Training_completion_rate-Quiting_rate_of_IE-Firing_internal_experts
Internal_processing_capacity = Productivity_of_IE*Manhours_dedicated_for_task_processing
Last_5_week_avarage_cost = IF TIME= 20
THEN
MEAN (HISTORY (Weekly_cost,15), HISTORY (Weekly_cost,16), HISTORY(Weekly_cost,17), HISTORY(Weekly_cost,18), HISTORY(Weekly_cost,19))
ELSE 0

- Longterm_cost = IF TIME= 20
THEN
MEAN (HISTORY (Weekly_cost,10), HISTORY (Weekly_cost,11), HISTORY(Weekly_cost,12), HISTORY(Weekly_cost,13), HISTORY(Weekly_cost,14))
ELSE 0
- Manhours_dedicated_for_task_processing = Total_manhours_of_IE - Manhours_dedicated_for_training
- Manhours_dedicated_for_training =
MIN((Total_manhours_of_IE*Max_fraction_of_time_for_training),(Manhours_needed__to_train_a_trainee__for_one_week*Total_trainees'))
- Manhours_dedicated_for_training_tm1 =
MIN((Total_manhours_of_IE_tm1*0.5),(Manhours_needed__to_train_a_trainee__for_one_week*Total_trainees_tm1))
- Manhours_needed__to_train_a_trainee__for_one_week = 10
- Max_fraction_of_time_for_training = 1
- Max_tasks_to_be_processed = (Backlog_of_tasks_'t_minus_1'+Task_arrival_rate)/Time_to_process_a_task
- Mean_task_arrival_rate = 1000
- Normal_Stage_1_completion_rate = Trainees_1_'t_minus_1'/one_week
- Normal_Stage_2_completion_rate = Trainees_2_'t_minus_1'/one_week
- Normal_Stage_3_completion_rate = Trainees_3_'_t_minus_1'/one_week
- Normal_training_completion_rate = Trainees_4_'t_minus_1'/one_week
- one_week = 1
- Productivity_of_EE = 1
- Productivity_of_IE = 1
- Quiting_fraction_of_IE = 0.05
- Seed = 1
- stage4_manhours_need_tm1 = Trainees_4_'t_minus_1'*Manhours_needed__to_train_a_trainee__for_one_week
- Stdev_of_task_arrival_rate = 200
- Time_allocated_for_training = (Manhours_dedicated_for_training/Total_manhours_of_IE)*100
- Time_to_fire_an_expert = 1
- Time_to_process_a_task = 1
- Total_cost' = Accumulated_backlog_cost_at_t+Accumulated_cost_of_EE_at_t+Accumulated_firing_cost_at_t+Accumulated__cost_of_IE_at_t
- Total_External_Decision =
HISTORY(Hiring_external_expert_decision,0)+HISTORY(Hiring_external_expert_decision,1)+HISTORY(Hiring_external_expert_decision,2)+HISTORY(Hiring_external_expert_decision,3)+HISTORY(Hiring_external_expert_decision,4)+HISTORY(Hiring_external_expert_decision,5)+HISTORY(Hiring_external_expert_decision,6)+HISTORY(Hiring_external_expert_decision,7)+HISTORY(Hiring_external_expert_decision,8)+HISTORY(Hiring_external_expert_decision,9)+HISTORY(Hiring_external_expert_decision,10)+HISTORY(Hiring_external_expert_decision,11)+HISTORY(Hiring_external_expert_decision,12)+HISTORY(Hiring_external_expert_decision,13)+HISTORY(Hiring_external_expert_decision,14)+HISTORY(Hiring_external_expert_decision,15)+HISTORY(Hiring_external_expert_decision,16)+HISTORY(Hiring_external_expert_decision,17)+HISTORY(Hiring_external_expert_decision,18)+HISTORY(Hiring_external_expert_decision,19)
- Total_internal_decision = HISTORY(Hiring_trainee_decision, 0)+HISTORY(Hiring_trainee_decision, 1)+HISTORY(Hiring_trainee_decision, 2)+HISTORY(Hiring_trainee_decision, 3)+HISTORY(Hiring_trainee_decision, 4)+HISTORY(Hiring_trainee_decision, 5)+HISTORY(Hiring_trainee_decision, 6)+HISTORY(Hiring_trainee_decision, 7)+HISTORY(Hiring_trainee_decision, 8)+HISTORY(Hiring_trainee_decision, 9)+HISTORY(Hiring_trainee_decision, 10)+HISTORY(Hiring_trainee_decision, 11)+HISTORY(Hiring_trainee_decision, 12)+HISTORY(Hiring_trainee_decision, 13)+HISTORY(Hiring_trainee_decision, 14)+HISTORY(Hiring_trainee_decision, 15)+HISTORY(Hiring_trainee_decision, 16)+HISTORY(Hiring_trainee_decision, 17)+HISTORY(Hiring_trainee_decision, 18)+HISTORY(Hiring_trainee_decision, 19)
- Total_manhours_of_IE = Weekly_working_hours*Internal_experts'
- Total_manhours_of_IE_tm1 = Weekly_working_hours*Internal_experts_'t_minus_1'
- Total_trainees' = Trainees1+Trainees2+Trainees3+Trainees4
- Total_trainees_tm1 = Trainees_1_'t_minus_1'+Trainees_2_'t_minus_1'+Trainees_3_'_t_minus_1'+Trainees_4_'t_minus_1'
- Total_weekly_manhours_of_EE_tm1 = Weekly_working_hours*Hiring_external_expert_decision
- Trainees1 = Trainees_1_'t_minus_1'+Hiring_trainee_decision-Stage_1_completion_rate
- Trainees2 = Trainees_2_'t_minus_1'+Stage_1_completion_rate-Stage_2_completion_rate
- Trainees3 = Trainees_3_'_t_minus_1'+Stage_2_completion_rate-Stage_3_Completion_Rate
- Trainees4 = Trainees_4_'t_minus_1'+Stage_3_Completion_Rate-Training_completion_rate
- Training_coverage_ration_for_4_tm1 = IF (stage4_manhours_need_tm1=0 OR
(Manhours_dedicated_for_training_tm1-stage4_manhours_need_tm1) >0)
THEN 1
ELSE Manhours_dedicated_for_training_tm1/stage4_manhours_need_tm1
- Training_coverage_ratio_for_others_tm1 = IF (Total_trainees_tm1 - Trainees_4_'t_minus_1' = 0)
THEN 1
ELSE
(IF Training_coverage_ration_for_4_tm1 < 1
THEN 0
ELSE (Manhours_dedicated_for_training_tm1- stage4_manhours_need_tm1)/((Total_trainees_tm1 - Trainees_4_'t_minus_1')
*Manhours_needed__to_train_a_trainee__for_one_week))
- Unit_backlog_cost_of_a_task = 10
- Unit_cost_of_firing_an_expert = 2000
- Weekly_capacity_usage = IF Total_processing_capacity=0
THEN 1 ELSE
('Task_Completion_Rate'/Total_processing_capacity)*100
- Weekly_cost = IF TIME= 0 THEN 0 ELSE Weekly_backlog_cost+Weekly_firing_cost+Weekly_total_cost_of_EE+Weekly_total_cost_of_IE
- Weekly_cost_of_an_EE = 3000
- Weekly_cost_of_an_IE = 500
- Weekly_working_hours = 40