

Utilizing System Dynamics Modeling to Assess Force Readiness in Sustainment Brigades

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Author Note: The views expressed here are those of the authors and do not reflect the position of the United States Military Academy, the Department of the Army, or the Department of War.

Abstract: This paper examines the recruitment and retention challenges faced by the 92 and 88 series Military Occupational Specialties (MOSs) within sustainment brigades, focusing primarily on retention. The Systems Dynamics Modeling Process (SDMP) is applied to expand an existing System Dynamics model to better visualize how personnel flow within their respective unit over time. The model explores the effects of change using four policy levers applied to the population, including increased pay, increased time on station, education opportunities and enhanced broadening opportunities. Although calibration of the model is beyond the scope of this research due to data availability, using a thorough trend analysis of the model output validates the model structure and paves the way for future calibration research.

1. Introduction

This paper explores recruiting and retention challenges for 88 and 92 series Military Occupational Specialty (MOS) soldiers and evaluates potential policy levers using a System Dynamics model. Additionally, conclusions will be drawn for sustainment brigades at large, given that 88 and 92 series soldiers bear significant responsibility for sustainment brigade readiness.

The motivation for this research is to support the office of the Deputy Assistant Secretary of War for Readiness Analytics (DASW-RA) and expand their research into personnel readiness decisions at the larger Department of War level. The authors used an existing DASW-RA system dynamics model from 2025 which used Armored Brigade Combat Teams (ABCTs) as a case study. That model approach is a valid correlation to sustainment brigades, as the underlying structure to progress a soldier through their career is the same regardless of MOS, and exogenous variables can be adjusted to account for differences in specific MOS transition rates.

The assumptions on the total enlisted population of a Sustainment Brigade mark a good starting point for a new model that could be tailored using the proper data points. The policy levers include dwell ratio, education incentives vs the baseline of what the Army currently offers soldiers, enhanced broadening opportunities, average time on station, pay raise to match inflation, training adjustment time, and increased recruiting goals multiplier.

2. Background

As the Department of War emphasizes force readiness, Sustainment Brigades are a major piece of that puzzle. Sustainment Brigades are multi-mission units that help enable operations across multiple domains. A sustainment brigade's mission, according to Army Techniques Publication (ATP) 4-93, is to provide support and services that enable operational reach, ensure freedom of action, and extend endurance for Army forces. This is reflected in the mission statement of the 82nd Airborne Division's Sustainment Brigade, with the goal to enable sustainment for forcible entry and contingency operations to the Nation's global response force (82nd Airborne Division). Sustainment Brigades directly impact force readiness by enabling warfighters. Force readiness encompasses preparing for war, fighting and sustaining during war, and recovery operations after a war. The Sustainment Brigade is a critical asset for both the personnel and equipment readiness, supporting the overall force readiness.

As warfare evolves and modernization advances, Sustainment Brigades need to keep pace to support the warfighter. Stated by MG Michelle K. Donahue, "Logistics is no longer a rear-echelon function; it is a frontline enabler. As maneuver formations become lighter, faster, and more distributed, the Army must reshape its sustainment formations to deliver continuous support under fire, in degraded conditions, and across contested domains" (Transforming Sustainment to Win the Future Fight, 2025). The ability of the Sustainment Brigade to meet the requirements stated by MG Donahue is largely dependent on having

the required number of personnel in each unit to accomplish their myriad of tasks. The only way to effect the personnel in the unit is by recruiting new soldiers, or retaining existing soldiers at a higher rate.

Retention is critical to the Army because it directly sustains force readiness and operational effectiveness through leadership continuity. Research consistently shows that retaining experienced mid-career officers and non-commissioned officers preserves institutional knowledge, unit cohesion, and leadership expertise that cannot be replaced through recruitment alone (RAND, 2025). High retention also supports readiness by ensuring units are staffed with trained, deployable soldiers by reducing skill gaps and the time and cost associated with repeated recruiting and training cycles (Lipsky, 2020). Studies by the DoD Office of People Analytics further demonstrate that facts such as career satisfaction and family support strongly influence retention intentions and, in turn, readiness outcomes. Ultimately, a decline in retention, particularly among mid-career officers, disrupts leadership continuity and reduces unit effectiveness in the Army. Thus, retention is not simply a personnel management issue. It is a strategic requirement for sustaining a capable and ready force.

Overall, the project is focused on 92 and 88 series MOS's. Both of the MOSs are organic to a Sustainment Brigade's function. Looking at the possibility of offering extensive training and certification that can be offered from outside sources. Offering the extensive training and certification for MOS 92 and 88 will not only retain soldiers but it could also enhance their skills and abilities. Enhancing the abilities of these soldiers will better enhance force readiness capabilities.

3. Methods

This research applies the System Dynamics Modeling Process (SDMP) to analyze the problem. The SDMP is divided into five stages, those being problem articulation, dynamic hypotheses, formulation, testing, and policy evaluation/formulation. The project culminates in the proposal of a new retention policy lever, titled "enhanced broadening opportunities". The goal for the new policy lever will be to enhance NCO retention through professional development with private industry.

One way in which the Logistics Branch increases managerial capabilities within its officer corps is the Training with Industry Program (U.S. Army Acquisition Support Center, n.d.). In this program, post-company command captains get to spend a year with a company, building knowledge of what good practices in industry look like (Crowley, 2022).

Given the successful application of TWI to the Officer Corps, it raises the question of what the impacts would be should TWI be available to NCOs. There are many domains in which the Army operates that require specialized experience. The Arctic, for example, has operational complexities unique to that specific environment. Additionally, the Army expects senior NCOs to possess a wealth of technical experience, which only TWI can enhance.

It is important to note that the TWI program guarantees retention. As it stands, officers incur a 3-to-1 ADSO should they elect to partake in the TWI program. Additionally, the break in service would likely have a couple of 2nd order effects. First, it would equip NCOs for career advancement outside of the Army. It is well known that NCOs often lack the opportunities necessary to keep pace with officer counterparts when finding outside employment, and TWI eligibility could help close that gap. Additionally, it is possible that TWI could have the effect of burnout reduction. A year outside of the military may leave participants refreshed for when they go back in, often at higher leadership billets.

To test the policy levers for this project, a framework model was needed. Even though research was focused on Sustainment Brigades and Logistics Personnel, the framework for the model was based on Armored Brigade Combat Teams and Armor Personnel (Lueders, 2025). Although not organic to logistics personnel, the model assumes that there is a baseline set of policy levers that have effects on personnel retention at a broader level.

3.1. Formulation

The team separated the modeling process between 88 and 92 series of Sustainment Brigades. The general structure encompasses six views: Dashboard, Transition Rate, Individual Series Promotions, Promotions, 88 Series Assignment, and 92 Series Assignment. The team adopted a bottom-up approach in the modeling process; modeling each individual Series before combining them into an aging chain of Enlisted personnel in Sustainment Brigades. The core components of the System Dynamics Model are the transition sentiment model, transition rate model, and the enlisted promotion aging chain.

3.1.1. Background Model - Armored Brigade Combat Teams

The ABCT model that forms the basis of this sustainment brigade model was constructed for DASW-RA in 2025 as a project for the Department of Systems Engineering Operations Research Center. A brief overview of that model structure follows to justify its adaptation to the sustainment brigade model. The ABCT model uses a top-down approach, modeling enlisted soldiers at the whole Army level first. The model was calibrated to match declining end-strength projections at its baseline. Once the model roughly matched existing projections in each pay grade, the model then explores transition sentiment, where an increase from the baseline causes a higher transition sentiment, leading to a higher transition rate from the Army. If

transition sentiment decreases, meaning soldiers are more likely to stay in the Army, then the transition rate decreases. The transition rate adjusts from the baseline based on policies enacted regarding pay, station time, educational opportunities, dwell, and unit fill ratios. This total enlisted model is then used to drive the assignment model for ABCTs, where soldiers are either assigned to an ABCT unit or a non-ABCT unit. The effect of senior leader decisions to change policy then propagates through the model, altering the readiness level in the ABCT population and better informing those leaders of the impacts of their decisions. (Lueders, 2025)

3.1.2. Transition Sentiment

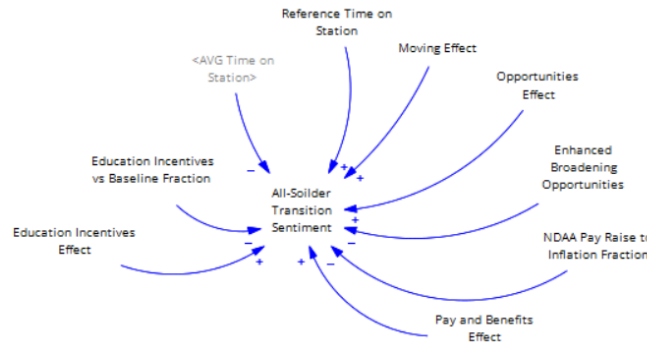


Figure 1: Transition Sentiment Generation from Policy Levers in Vensim.

Figure 1 shows a causal loop diagram of the variables that affect the Transition Sentiment in Sustainment Brigades. The outputs are then multiplied as shown in equation (1):

$$\begin{aligned}
 \text{All soldier transition sentiment} = & \text{Moving Effect} \left(\frac{\text{AVG Time on Station}}{\text{Reference Time on Station}} \right) \\
 & \times \text{Pay and Benefits Effect (NDAA Pay Raise to Inflation Fraction)} \\
 & \times \text{Education Incentives Effect (Education Incentives vs Baseline Fraction)} \\
 & \times \text{Opportunities Effect (Enhanced Broadening Opportunities)}
 \end{aligned} \tag{1}$$

All soldier transition sentiment is a dimensionless multiplier that can increase or decrease the transition rate. It captures the perceived attraction of leaving the Army. It is a function of all the policy levers shown in Figure 1.

3.1.3. Transition Rate

The transition rate is the frequency of Enlisted personnel leaving the Army. This rate is driven by the current average transition rate in the Army, and a transition sentiment multiplier

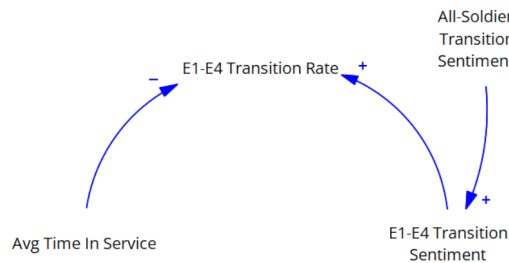


Figure 2: E1-E4 Transition Rate Model.

Figure 1 shows the transition rate structure of E1-E4 personnel. Due to the close nature of civilian opportunities that attract the 88 and 92 series Enlisted personnel, the team assumed that the 88 and 92 series have an equal transition rate. The

transition rate is a frequency value calculated by dividing the transition sentiment by the average service time of a soldier, as shown in equation 2:

$$E1-E4 \text{ Transition Rate} = \left(\frac{E1-E4 \text{ Transition Sentiment}}{AVG \text{ Time In Service}} \right) \quad (2)$$

3.1.4. Promotions

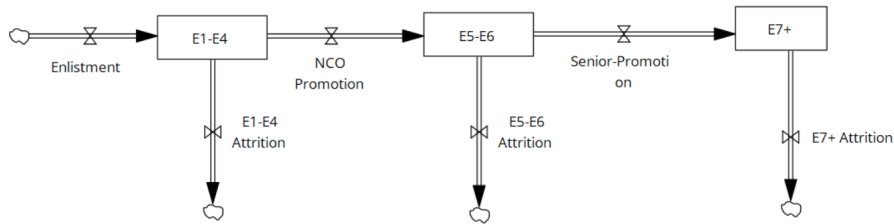


Figure 3: Aging Chain of Enlisted Personnel.

Figure 3 appears in the Promotions view; it is a Vensim aging chain model that captures the structure of the enlisted personnel and generates their readiness behavior. The model has 3 stocks for the 3 rank groups of enlisted populations in sustainment brigades. The flows are Enlistment, Promotions and Attrition. The team used this basic structure to model both 88 and 92 series aging chains. Attrition is the rate at which soldiers leave the rank group, excluding promotions.

4. Results

4.1. Testing

4.1.1. Dimensional Consistency Test

This test checks if the units that the team inputted in the variables, stocks, and flows are consistent with the resulting units generated within the model structure. The Vensim built-in function, Units Check, ran the whole model for dimensional consistency.

4.1.2. Extreme Conditions Test

The team compared the Transition Rate of a 0 and 2 Enhanced Broadening Opportunities lever. The two extremes generated a maximum rate of 0.25 and 0.06, respectively. The model passed the extreme conditions test because it is able to handle the extreme conditions of the Enhanced Broadening Opportunities that the team assumed.

4.1.3. Sensitivity Analysis



Figure 4: Tornado Graph of Transition Sentiment

The Enhanced Broadening Opportunities lever has the biggest effect on transition sentiment. The lever caused a change in the Mean Absolute Deviation (MAD) of 0.14, opposite a 10% reduction. It also caused a change of 0.1, opposite a 10% increase, as shown in Figure 4. Although the lever cannot be properly calibrated, the Department of the Army Career Engagement Survey (Vice and Lathrop, 2024) cites that continued growth is a key reason why NCOs choose to stay in the Army.

4.2. Policy Formulation and Evaluation

Table 1: Policy Formulation in Vensim.

Levers	Policies			
	Base	Increased Station Time	Increased Pay	Enhanced Opportunities
Enhanced Broadening Opportunities	1	0.8	1	1.5
NDAA Pay Raise to Inflation Ratio	1	1	1.5	1.1
Reference Time on Station	36	54	36	45
Education vs Baseline Fraction	1	0.8	1	1.4

The team used the transitive property of inequalities to formulate the lever values for each policy. The values are assumptions from qualitative data in relation to the status quo. The team assumed the highest value under for Enhanced Broadening Opportunities under Enhanced Opportunities as it is its primary objective. Increased Pay has no direct impact on broadening opportunities. Increased station time counters opportunities since the fewer units a soldier is exposed to, the lower the broadening opportunities. The team deduced this qualitative reasoning into quantitative values, respecting the transitive property of inequalities, as shown in Table 1.

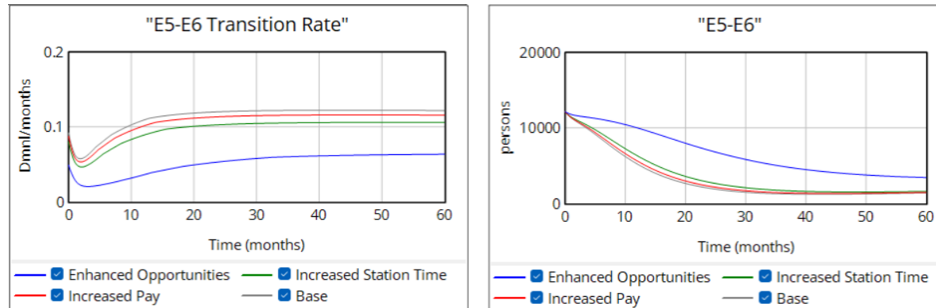


Figure 5: E5-E6 Policy Behavior vs. Base.

The Army designs a certain number of transitions to meet retention quotas, thus contributing to downward trends in the personnel population, as reflected by the E5-E6 graph in Figure 5. The E5-E6 slope generated by the Enhanced Opportunities is the least steep, this indicates that the policy is more likely to retain personnel for a longer period. This effect is more profound during the first 30 months of implementation, as this is where the gap between the policy and the alternatives is largest.

5. Limitations

One key issue with the project was the validation of the model. Though the Army has become data-centric in recent years, the data collection to tie retention statistics to the policy levers in a quantitative manner does not exist. However, the value of modeling these policy levers in a qualitative manner was leveraged by analyzing their trends relative to the Department of the Army Career Engagement Survey results, which provides a level of directional calibration to the model. Future calibration may be possible with a thorough trend analysis using Palantir’s Army Vantage platform, but that analysis may require a dedicated research scope to make connections with past Army policy changes and subsequent retention statistics. Additionally, the model was reliant on assumptions derived from overall Army statistics. We had to assume the average number of soldiers in a Sustainment Brigade, a number crucial to the functioning of the model.

6. Conclusion

Overall, this project framework has provided good insight into how actions taken at the DoW level can increase retention for experienced logistics personnel within Sustainment Brigades. Additionally, the System Dynamics model will enable senior leaders to predict the personnel dynamics resulting from policy implementations that have a long-term impact on operational performance. Examining enhanced broadening opportunities offers insight into a relevant contemporary challenge, for the Army increasingly finds itself competing with civilian industry in the same talent pool. This is especially true for logistical MOS's, such as 88 and 92 series. A similar methodology could be applied to cyber MOS's, as evidenced by the DoW-wide struggle to retain talent in the cyber space (Industrial Cyber, 2023).

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