Learning Priorities and the Role of Computer-Based Training and Simulation on Military Supply Chain Logistics

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ABSTRACT

Military training involves activities that range from combat operations to strategic decisions on how to locate and transport personal and supplies, such as food, ammunition, fuel and medical equipment. Despite of the fact that most military training is difficult to acquire from real situations, the skills required for learning from combat training technology are different from those required for training on military logistics. This research work aims to analyse learning priorities and the role of Computer-Based Training and Simulation (CBTS) on Military Supply Chain Logistics. Military logistics is a complex task that requires expertise for decisions on such factors as: (i) the mission to accomplish; (ii) the place to locate troops and all military facilities at the Area of Operations (AOO); the (iii) combat readiness level that will be expected to equip all the military operations; and the (iv) use of transportation resources and paths to follow in the AOO. In this work, each one of these factors is represented by a number of variables that must be considered as whole to outline the best decisions on supply chain logistics for each military operation. To identify training priorities for considering the implications of all variables that respond for these four factors, this work carried out a qualitative research with in depth interviews with military personal with expertise on making decisions about military logistics. Results from this research shows the skills that are most important to follow for developing expertise on military supply chain logistics and the technology that should best be applied to enhance the training experience. Conclusions from this work shows that training on military logistics involve decisions that are mostly unique, though the current computer-based technology has an important role for training and simulating field situations, thus enhancing the required expertise for making decisions on real military supply chain operations.

1.0 INTRODUCTION

As a broad concept, logistics is a planning orientation that aims to build an approach for the flow of products and information to support the achievement of an objective [1,2]. The supply chain objective can be related to business (as building a car or selling worldwide products in a supermarket), to military operations (as providing supplies and relocating military forces) as well as to humanitarian and non-profit operations, such as international efforts for helping with major natural catastrophes. As a military application, supply chain logistics involves all planning tasks necessary for moving armies and keeping them supplied [3]. The drive for supply management is co-operation and trust, recognizing that, if properly managed, the sum of all parts involved provides benefits to all, which no individual could achieve by itself [4,5,6].

The challenge of a supply chain is about the management of relationships to achieve all planned objectives and results that benefits all parties involved [2]. Another import aspect of supply chain is that effective logistics can provide competitive advantage, even when it involves taking a position of enduring superiority over competitors, as well as a successfully accomplishing a military mission. For business matters, superiority is related to aspects as customers' preferences, process optimization, low cost and high quality for products and services [1,2]. For military operations, it is crucial to endure superiority over competitors, as the mission is the real challenge and supply chain logistics is a crucial factor for its success. Although military superiority involves aspects that may have nothing, or very little, in common with business activities, both are related to accomplishing a plan with the best use of resources of all parts involved [6,7].

Military logistics operations involves a systemic support for offensive, defensive and stability of military operations [6]. The identification of supply chain factors that are important for supporting military operations and the problems that are associated with particular types of warfare, missions and locations are key for assuring the success of operations. Military logistics for supply chain management involves a multitude of ways to increase efficiency and to reduce costs for accomplishing the mission. It involves strategic management of military forces and combat operations, and highlights the close relationship between military logistics and military strategies [3,5]. As every military operation is unique, supply chain requirements are also unique, though planning and anticipation for aligning military strategies with military supply chain logistics are key for the success of all military operations [5].

Currently, military practices have been moving from a heavy structured model with massive amount of equipment and personnel towards a more flexible, faster moving, and lean structures, though maintaining the combat power strategies [3]. An army must be seen as an organization that is continuously evolving for delivering military power, which is directed by executives with field and managerial expertise. Military operations involve a combination of personnel and equipment supplied by a continuous support logistics, which requires decisions to quickly adapt to constantly changing situations [8]. Behind these decisions are factors regarding the mission to perform, the place where the troops and all military facilities are located, the technology and equipment that is necessary to provide and the transportation equipment and skills of the supply service personnel [9].

The effectiveness of the military support services depends on the skills and knowledge of decision makers for employing the latest advances in military supply chain logistics, considering enhanced situational understanding for maximizing the use of all available resources, which might come from multinational efforts, hosting nation and contracted sources [4,9]. The military logistics decision making involves a systematic approach to provide a plan that involves a series of actions occurring in sequence, as well as simultaneously. These are knowledge intensive decisions that can get help from experience, though there hardly will be situations that are similar, as there is a number of different missions, locations and a constant evolution on military equipment and logistics. For building the plans is required a logic clarity of judgment and professional expertise, which depend of military training effectives.

Nurture leaders to meet the challenges of current and future military logistics, considering a systemic view of

the mission and constant developments of IT resources requires continuous training for military personnel. This research work aims to analyse priorities for training on military supply chain logistics. The research also evaluates the status of current Computer-Based Training and Simulation (CBTS) for improving skills of military personnel on supply chain logistics. Results from this work show the current alignment between training needs for military supply chain logistics and CBTS applications.

2.0 Military Strategies and Supply Chain Logistics

> "As a whole, military logistics has the objective of making simple a very complex task of allowing the military to operate and optimizing the use of resources. It takes little skill or imagination to see where you would like your army to be and when. However, it takes much knowledge and hard work to know where you can place and whether you can maintain them there. A real knowledge of supply and movement factors must be the basis of every leader's plan. It allows knowing how and when take risks with those factors, and battles are won only by taking risks" [9].

Military logistics is about estimating needs for providing Combat Support Service (CSS) to military forces [10]. It is a complicated task that requires highly trained logisticians to coordinate and manage all movements and maintenance of military forces [4]. CSS involves defining the tasks and capabilities necessary to sustain all operating forces and includes distribution of supplies, equipment maintenance, transportation, health services and managing facilities, such as personal cleansing, laundry and mortuary [10,4,9].

Though military logistics involves tasks that are unique for every different mission, there are principles that have stood the time with military operations, though equipment, weaponry and technologies are constantly evolving. As a general principle, there are no detailed best practices to help making decisions on military logistics. The literature review shows that there are handbooks, guidelines and standard operating procedures, mostly developed by military institutions, trying to bring some structure and standards for military supply chain logistics [10,11,12]. Although different military and jointly efforts adopt different procedures, there are also some common principles, such as [10,11,12].

- Primacy of Operations - it must be focused on ensuring the mission success and integration as a unique operational structure that follows an unequivocal chain of command and co-ordination, which is suited to each specific situation.
- Authority – there should be an alignment between commanders rights and responsibilities regarding the authority for making decisions over the use of logistic resources in the most effective manner;
- Co-operation – copes with individual and allied forces working together for both, the provision and management of logistic support including financing, accounting, financing and communicating;
- Provision and Sufficiency – operations must endure the provision of adequate logistic resources to support allocated military forces to operate;
- Agility – as no logistic plan will suit all situations, plans must be established with the knowledge that unexpected shall occur, thus it is important to be able to respond quickly and efficiently to changes in the operational scenario;
- Flexibility – Military logistics plans and operations must be clear, objective and avoiding confusion on ensuring an accurate and efficient dissemination of information to all those involved with the military mission
- Economy – military support must be cost efficient, considering economies of scale, increase reserve capacity/capability and the overall quality of support, while minimizing procurement, operational costs and fulfilling operational imperatives.

- Transparency and Visibility – information about military logistic plans and operations must be available to access and that relates to preparedness, deployability, and sustainability of all force units;
- Synergy - is a benefit that is achieved by applying all logistic principles systemically and all military forces contribute to a common goal, thus the net benefit is greater than the sum of all separate contributions.

Despite of mission complexity and whether it involves an integrated multinational logistic force or purely national support, a military logistician often work with a staff of multidisciplinary officers and it is important to appreciate other's opinion and delegate responsibilities. However, these principles must prevail throughout the operation life cycle of any military mission [13].

Military logistic involves all support required for fulfilling a military mission. In this work, the military logistic plans and operations start when a place and mission are received from a higher military command and reach up to the evacuation and return of all military forces. Combat strategies involving types of weapons, course of action, troops' profile, and time to fulfil the mission are part of the input from the higher command that starts the military logistics process. From that higher command input, the mission analysis starts and initially focuses on gathering intelligence, surveillance, and reconnaissance data and information. The following step involves planning guidance that focus on the course of action and how the military forces intents to employ combat power to accomplish the mission. Though the military combat strategies are not focused in this work, the military logistic and CSS to accomplish the mission are defined based on principles and key priorities of the military operation.

The main outcome from the mission analysis stage is the military logistic planning guidance, whose level of detail depends on the time available, staff's proficiency, and the scope required by the higher command [14]. The more detailed the guidance, the slower the operating logistic staff can complete the plan. However, a higher level of details means lowering risks for insufficiently examining things that might affect mission success [13,14]. Moreover, experienced military logistic personal have a key role on developing the military logistic plan, as it requires intensive knowledge and expertise [14].

The four main stages of the military logistics are presented in Figure 1 and it involves: (i) mission analysis, (ii) locating facilities, (iii) operating mission and, (iv) site closure. Planning is the task focused in this work and involves the most of logisticians' skills and expertise and the figure shows that it covers all military logistic stages, though it is more required on the first (i) and last (iv) stage. Planning on stage (i) involves a strategic definition of all tasks and resources necessary to transport and sustain all operating forces. On stage (ii) the military logistics involves activities that are more related to preparing for making the actions planned to work. It includes pinpointing resources, pathways, transportation equipment and place to locate military forces. Planning in this stage (ii) is more about reviewing previous actions based on unexpected occurrences and inconsistencies in the actual logistic plan. On stage (iii) the focus is more on executing the logistic plan. As all military operations are unique and complex, it is expected that plans must be reviewed based on new "on site" information, such as unanticipated threats or opportunities that may change the situation. On stage (iv) the logistic military planning is necessary to build strategies for returning all military forces and equipment. As the operations usually involves casualties and loss of equipment, the original plans must be reviewed, and it may even involve the creation of a specific plan for returning all military forces.

Figure 1 also shows that all four military logistics stages involve the task of assessing results from plans and operations. Military logistics planning involves tasks and operations that will be carried out in the future, though many aspects are assumed by decision makers. Although professional experience is important to bring those assumptions as close as possible to reality, plans cannot remain static [15]. The task of assessing logistic results offers feedback for reviewing and improving plans. Therefore, if carried out properly, the assess task can help providing a body of knowledge for military logistics training, showing details on the

initial plan as a point of departure for later adjustments and the reasons behind the changes.

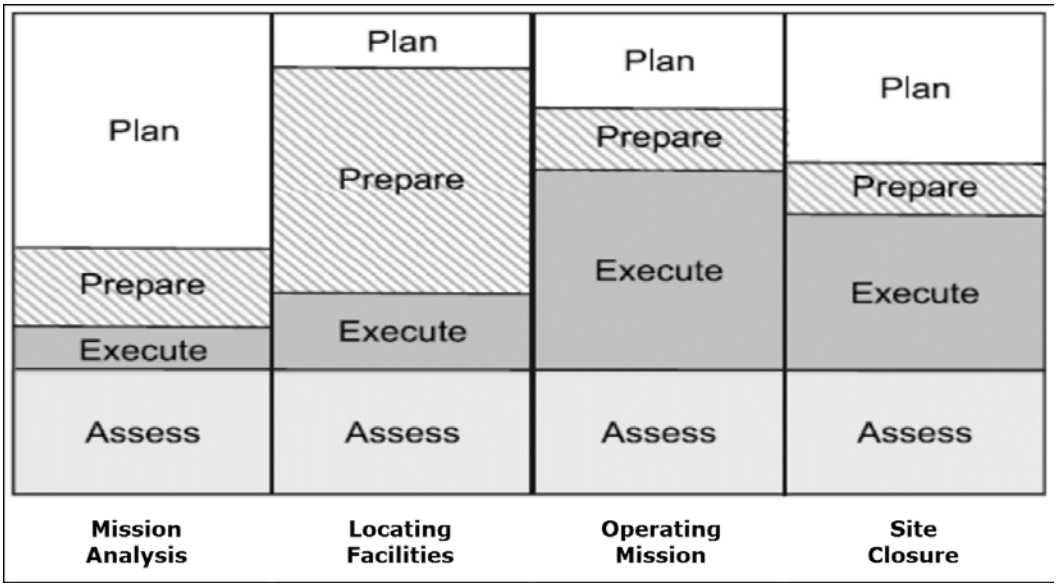

Figure 1 – Distribution of military logistics activities
Source: adapted from [11]

Information Technology (IT) resources have an important role on military logistics, that is continually growing with the development of new systems and devices. Although it is very important to have an understanding about the principles and methods for identifying, collecting and communicate information from the Area Of Operation (AOO), it is also important to have the skills for applying IT resources processed quickly and efficiently this information. For instance, digital imagery are currently pointed as one of the major assets for building a common understanding about the AOO scenario. IT can also be applied for training on military logistics and the current status of systems and application for improving the skills of logisticians are described in the following section.

3.0 TRAINING ON MILITARY LOGISTICS

Military logistics is a skill for those responsible for taking decisions on strategic warfare and tactical operations [15]. Though training has historically been one of the military priorities in peacetime, most courses are involved with combat techniques, doctrine, weaponry and military operations [10]. Military training for tactical and strategic activities are also available, but for high ranked officials and mostly taught into the classroom of military learning institutions by experienced logisticians [11, 12].

The necessary training skills for tactical military activities are well known and practiced on almost all military facilities, especially with new recruits [16]. There is also a range of computer systems and devices available for providing an experience that is similar to the one found in the AOO. However, as the military evolve to a higher hierarchic position and meet challenges on making decisions for strategic and operational military activities, computer based training and simulation systems become more difficult to find [9].

Nowadays, knowledge about military logistics is mostly gained through classroom training and field experience [11,9]. For military logistics, the training objective is of providing the skills for making a commander, who plays the most important role on the chain of command for supply chain planning. Commanders are engaged with making sure that the planning process meets requirements of time, cost effectiveness, efficiency, level of detail and all principles quoted in the previous section [11]. Commanders

are also responsible to ensure that all supply operation plans and orders are compliant with domestic and international laws and regulations [16,10].

IT resources have a growing role on almost every military activity, and military supply chain logistics is not an exception. The key to the success in evaluating and maintaining military forces at every level of support has always been about the ability to anticipate conditions in the combat area [16,20]. IT systems and devices can quickly and precisely provide data and information to support military logistics decisions and communicate with all actors involved. Therefore, logisticians are also supposed to be acquainted with the IT resources, as well as with the constant evaluation of electronic systems and devices.

CBTS for military logistics should be capable of assisting commanders to visualize the combat location and describe the combat scenario to subordinates. Commanders' visualization is a way of mentally viewing the dynamic and systemic relationship among allied forces, enemy forces, and the combat scenario while conducting supply chain operations [15]. Commanders' visualization ranges from the initial stage of mission analysis and continues throughout the operations process until the military forces accomplishes the mission. Currently, commander's visualization is a mental process that is difficult to communicate for providing a clear and broad situational understanding of all conditions in the combat zone [16]. The visualization must achieve a state that represents commanders' intent for accomplishing all tasks that move the military resources. Current CBTS can play a role in this scenario, especially with 3D visualization. There is also a possibility to simulate scenarios with different courses of action and to evaluate the options providing the best results for the military logistics [20].

Training for military supply chain logistics must not be limited to planned situations, neither to peacetime nor to military personnel [16]. It should also involve individual tasks molded into the units and the collective military forces. It must also involve paramilitary and civil units involved with the mission, and it all in a daily basis, as to follow new technology developments and threats [17]. Therefore, military training is about combat skills to survive and accomplish the mission, as well as with technical and strategic skills for anticipating needs and planning CSS.

4.0 EVALUATION OF CURRENT TRAINING ON MILITARY LOGISTICS

This section presents the research instrument for evaluating training needs for military supply chain logistics. The instrument was initially built from the literature review and further evaluated from the interviews with military logistics specialists. The objective of the research instrument was of providing a comprehensive evaluation of the current state of the art in training for military supply chain logistics, as well as to identify opportunities for improving it, with CBTS. To build the instrument and to represent the key planning activities of military supply chain logistics, the instrument was developed considering the following aspects:

- Identifying the most important skills and activities required for making decisions on military logistics;
- Assessing the current training methods and requirements that are specifically associated with each military logistics activity;
- Mapping training needs associated with existing technologies for computer based training and simulation.

The first version of the research instrument was developed with 4 major military logistics factors and 29 variables representing specific tasks of military logistics. As part of the interviewing process, the instrument was reviewed and the final version kept the structure with for factors, though some variables were changed, and it now contains 27 variables. The structure and variables in the final version of the research instrument are following listed and the formatted research instrument is on Appendix 1.

- **Mission Analysis** - aims to identify key tasks required or implied to accomplish the military mission [4,13].
    - Provide a description of the military operation to be accomplished;
    - Identify key tasks required to accomplish it and breakdown the needs in a plan;
    - Define the skills necessary to accomplish the mission;
    - Prepare staff estimates to accomplish the mission, defining roles and responsibilities for all;
    - Evaluate key factors for the military logistics structure;
    - Identify logistics constraints (costs, personnel, equipment, rules of engagement);
    - Set up the logistics planning for staff integration (nations, actors, commanders);
    - Develop the mission planning guidance;
    - Communicate actors about the logistic concept (movements, supplies, medical, etc.)
- **Combat readiness level** - involves planning to identify and manage supplies for arming, fueling, feeding, repairing and clothing the military forces, to assure an efficient use of resources to accomplish the mission [4,13].
    - Define strategic lines of communication and procedures to locate and discipline wired/wireless communications;
    - Identify host nation support;
    - Define Class I (rations), Class II (general supply) and all necessary support to assure subsistence for the military forces;
    - Take decisions over role-effectiveness vs cost effectiveness combat support;
- **Locating troops and all military facilities** - involves an evaluation of initial environmental conditions and access the overall site sustainability for defining the most suitable locations for base camps that maximizes the use of all available resources (multinational efforts, hosting nation, contracted sources, etc.) [4,18].
    - Identify all actual or potential conditions that can cause injury, illness, or death to personnel; damage to or loss of equipment or property; or mission degradation;
    - Assess potential hazards and evaluate probability, severity and level of risk for each one identified;
    - Develop, implement and inform personnel about risk control measures (administrative and physical) and how each will be implemented and monitored;
    - Supervise, manage and evaluate the effectiveness of the established site controls;
    - Management practices for eliminating inefficiencies to optimize the use of all site resources;
    - Define and maintain sanitation needs and final deposition for dejects;
    - Develop a site-specific sampling plan to define a collection of useful data for defining what substances to look for and sampling protocols;
    - Defining living, working and storage areas (fuel, arms, generators, waste management facilities, wash racks) along the base camp;
- **Transportation resources and paths to follow –** involves planning for transporting all military resources and paths to follow [4,18].

- Access the combat area and entry points (air, sea, roads, etc.)
- Movements across and within the AOO while continuing to support the mission
- Road construction (including needs for drainage, bridges, and flooding threats)
- Rotation and redeployment of military forces
- Site Closure and return of all troops and equipment

As part of this work and to fulfill the research objective, the respondents were asked to give thoughts on three kinds of questions for each variable, which were: (i) is it a key task for planning military supply chain logistics?; (ii) how training for planning this task is currently performed?; and (iii) what is the role of CBTS to improve skills for planning this task?. It is important to notice that the questions were not about training on how to perform (execute) the task, but about training for planning the tasks identified on all 27 variables in the research instrument. Further details about the methodology for carrying out the interviews are presented in the following section and the results on section 6 of this article.

5.0 RESEARCH METHODOLOGY

This work presents a qualitative and exploratory research that seeks for an understanding about the priorities for training on military agile supply chain logistics. This type of research is especially suited for cases in which neither there is a literature review specific to the area nor the researchers have an extensive knowledge on the matters related to the research problem [19]. Although there are several references exploring issues of military logistics and CSS, this work focus on identifying the main influencing factors for making decisions on military logistics, and the current computer based training and simulation for military personnel.

To deepen the understanding about the research objectives, qualitative interviews were carried out with experts experienced with decision making and training on military logistics. The interviewing process was conducted based on a semi-structured instrument, which was developed from the literature review. The research instrument was designed with three sections. The first (i) was responsible for mapping respondents' profile and position in the military hierarchy. The second (ii) aims at investigating respondents' opinions considering the 4 factors and 27 variables that represents activities for military supply chain logistics. The semi structured research instrument developed in this work is at the Appendix 1 of this work. The last section of the research instrument (iii) contains open questions for identifying general aspects of the research, such as opportunities and limitations that can be revealed, structure and instrument capability to fulfil the research objective, or reasons for the respondents' position on certain research aspects [19].

The questions in the research instrument followed a guideline for identifying interviewers' opinions about all training needs for making decisions on military logistics. It means that there was neither time limit nor an expected standard for the contents of the answers. The interviewees' selection was based on convenience and considering the proximity to the researcher, though respecting the criteria of more than ten years working experience with military logistics. A total of 3 experts with military logistics and training were interviewed and all viewpoints were compared for the result analysis. Therefore, the criteria of choosing experts with large experience for a deep understanding of each question prevailed over having a great amount of opinions.

The interviews were conducted as face to face, focused, and informal, allowing the interviewees to feel free for openly discuss the topics in the research framework. This type of interview is often used for exploratory research, especially in cases where the researcher is dealing with unstructured knowledge [19]. The interviews were conducted during August and September 2013 and the respondents opinions was then confronted with the literature reviewed. The main advantage of a face to face interview is the opportunity to freely explore topics in depth, allowing the interviewer to feel comfortable for redirecting opinions and openly comment and justify their answers [19]. However, the task of encouraging respondents to talk freely

about the research topics belonged to the interviewer [19].

The interviews' content analysis was carried out for classifying, explaining and quantifying the respondents understanding about the research context and the military logistics aspects in the instrument. The content analysis applied thematic and categorical techniques, which are based on grouping the research issues into categories and explaining the context and application of the aspects present in the research instrument [19]. Though the interviews respected military policies and professionals' privacy, they were recorded for further analysis. The analysis performed in this work can also be repeated at a later date for comparing with the results obtained in this one, and thus evaluating changes on experts' opinions.

6.0 ANALYSIS OF RESULTS

A literature review has been carried out to identify the main planning tasks in the military supply chain logistics. The final version of the research instrument is at the Appendix 1 and has been used as a guideline for the interviewing process and to collect data from the military supply chain experts. To fulfill the research objective, the intent was to comprise with all key planning activities present in the four stages of military logistics, as shown in Figure 1. Thus, for each one of the 27 variables in the research instrument, the respondents were asked to give an opinion on 3 questions, which are:

i. Is it a key task for planning military supply chain logistics?

ii. How training for planning this task is currently performed?

iii. What is the role of CBTS to improve skills for planning this task?

During the interview, the experts were strongly encouraged to comment and justify their viewpoint on all items in the research instrument. As part of the interviewing process, all answers for the questions about the (iii) role of CBTS were asked for details on the type of technology and justifying its benefits for learning that particular skill. All interviews were performed in August and September 2013 and took respectively 85, 72 and 66 minutes. Further details on experts profile are presented as follow.

6.1 Experts profile

This research work was developed as a qualitative and exploratory research that aims for a deep understanding of a phenomena, which is the training on military supply chain logistics. Research data was collect from in-depth interviews performed with experts on military logistics. The interviews were carried out to analyze the role of CBTS for improving skills on planning military supply chain logistics. Therefore, it was important to have military logisticians experienced in the field, both as a planner as well as with training in the field. As part of the research work, three experts were interviewed and all have more than 15 years of work experience with fielded activities and training on military logistics. The latter criteria of being engaged with training on military logistics was important to assure that the experts were aware of current state of the art training on military logistics and the skills necessary to become a high ranked military logistician.

The experts' identity is preserved and they will be called as Expert 1 (E1), Expert 2 (E2) and Expert 3 (E3). E1 works in the military for over 28 years and for over 22 years involved with military logistics. E1 was the most experienced respondent in this research and has been involved in several military missions worldwide. At first, E1 started with tactical operations and currently, for more than 12 years, with strategic military logistics planning activities. E2 is a former military who is now working as an academic civilian in a university, teaching issues related to civil and military supply chain logistics. E2 has a strong international experience with teaching and researching on military supply chain logistics that was especially useful in this work. E3 is also a military that works in the army for over 20 years, and has always been involved with military logistics, since tactical operations to strategic decision making. E3 training experience is related to internal military personnel and current training technology and practices for military logistics. All opinions

for current and future on CBTS for military supply chain logistics is presented as follows.

6.2 Mission Analysis

Planning military supply chain logistics for analyzing the mission is the first and most comprehensive task for logisticians. It starts when a superior military command presents the mission to accomplish, showing general planning details such as the time to start, period to stay on the different AOO, and date to return all military forces. Based on the mission guidelines, the military logisticians can start planning all supply chain activities. It is important to highlight that mission analysis, from a logistic point of view, is a complex task that can even provide feedback to change the initial mission plan. Therefore, the tasks involved for developing the mission analysis are expected to be more complex than those represented in the research instrument. However, the instrument is trying to represent the most important tasks, though it is important to recognize that military logistics as a whole is not a static, linear and well defined as a sequence of tasks.

As part of the interview, respondents were asked to specify if the original 11 listed variables in the instrument were capable of representing key planning tasks of military supply chain logistics for the mission analysis. As part of the interviews, there was also an intent of validating the research instrument. E1 was the first interviewed, since he was the most experienced. The interview with E1 was carried out with 2 authors of this article: one experienced with military logistics, and the other with academic research. As for the importance of the variables, E1 suggested to eliminate one and to merge other two. Thus, from the original version with 11 variables, the instrument was changed to have 9 key tasks for representing the logistics planning for mission analysis. There was also some considerations about the text and sequence for the variables. Considering the strong arguments of E1, and in accordance with the researchers, mission analysis was thus represented by 9 variables. The following respondents (E2 and E3) agreed with the variables listed. Although they asked questions about details on most of these variables, they did not make any comments nor suggestions to alter anyone, thus agreeing with the planning tasks for mission analysis.

The interviews were open for respondents freely express their opinions about the variables. Table 1 shows a brief of the respondents' answers for two questions on each variable, which are: (i) there are training courses provided for military to perform this task; and (ii) if CBTS technology could help to improve the skills needed to perform this task. Positive answers are marked as Y (yes) and negative as N (no).

Table 1 – CBTS for planning mission analysis.

Mission Analysis	E1		E2		E3	
1. Provide a description of the military operation to be accomplished	N	Y	N	Y	N	Y
2. Identify key tasks required to accomplish it and breakdown the needs in a plan	Y	Y	N	N	Y	N
3. Define the skills necessary to accomplish the mission	N	N	N	N	N	N
4. Prepare staff estimates to accomplish the mission, defining roles and responsibilities for all;	Y	Y	Y	N	Y	Y
5. Evaluate key factors for the military logistics structure	Y	N	Y	N	N	N
6. Identify logistics constraints (costs, personnel, equipment, rules of engagement)	N	N	Y	N	N	N
7. Set up the logistics planning for staff integration (nations, actors, commanders)	N	N	N	N	N	N
8. Develop the mission planning guidance	Y	N	Y	N	Y	N
9. Communicate actors about the logistic concept (movements, supplies, medical, etc.)	N	Y	N	Y	N	Y

As a general comment, all respondents quoted that the 9 key tasks are currently learned from fielded experience and traditional training in classroom. Case studies from previous military operations are often

analyzed in classrooms for teaching and knowledge sharing. There are also books and military related references available for students to read and learn from previous experiences with CSS. However, the respondents could not indicate CBTS applications currently in use to help teaching these issues.

Respondents' opinion for the role of CBTS was hardly a positive consensus. Although they all agree that computer-based 2D and 3D images could help to communicate with all logistic personnel, there was not a clear role for this technology on teaching and learning with military logistics planning for mission analysis. For instance, all respondents agreed that computer-based visualization could play an important role for the variables 1 and 9. They also pointed out that they did not have experience with learning from computer-based education, neither have a knowledge about this technology and its potential for improving learning on the issue. However, they all pointed out that during classes there are many visual aids being used, such as slides, maps, pictures and satellite images.

6.3 Combat Readiness Level

This factor evaluates the key tasks for planning military supply chain needs, which involves quantifying and managing the necessary supplies for arming, fueling, feeding, healing, repairing and clothing the military forces. It was the most controversial factor in the instrument, as all respondents had initially the opinion that the variables it contains should be part of the Mission Analysis factor. However, the researchers argued that, in a way, all tasks in the instrument should belong to the Mission Analysis, and that this factor should be planned with the input from the tasks in the previous factor. They agreed on remaining as proposed in the instrument and though there was some minor adjustments with the language, the 4 original variables were kept in the instrument. Therefore, it was a consensus that results from this factor, mostly related to costs, could alter planning results from Mission Analysis. It was also a consensus that there is no well defined time line separating the factors and variables in the instrument, neither for planning supply chain logistics.

Table 2 shows that CBTS for the planning tasks in this factor is only a consensus if related to tools for calculating scenarios and supporting decisions about costs. All respondents informed that there are tools for imputing data related to Days Of Supply (DOS) and many other needs for CSS and logistics resources. These computer-based tools have not been originally developed for training, but for real military logistics demands. Based on the imputed data, these tools offer cost results for different scenarios, which helps making decisions for military logistics. These systems are also used for training, where military personnel play the role as a user, and get acquainted with the tools and how to input data and interpret results.

Table 2 – CBTS for planning combat readiness.

Combat Readiness Level	E1		E2		E3	
10. Define strategic lines of communication and procedures to locate and discipline wired/wireless communications	N	N	N	N	N	N
11. Identify host nation support	N	N	N	N	N	N
12. Define Class I (rations), Class II (general supply) and all necessary support to assure subsistence for the military forces;	Y	Y	N	Y	Y	Y
13. Take decisions over role-effectiveness vs cost effectiveness combat support	Y	Y	N	Y	N	Y

For variables 10 and 11 respondents commented that there are no actual CBTS technology for helping planning these tasks, neither should be any. For instance, E1 and E3 commented that variable 10 involves a task that requires especial telecommunication skills, and though it is a responsibility for the military communication engineering. Similar situation occurs for variable 11, as support from the nation in the AOO involves such complex negotiations that no current and future CBTS technology should be able to help.

However, for variables 12 and 13 the respondents were more kin on using and having help from CBTS

applications. For instance, all respondents commented that computer tools could have an important role to help evaluating costs scenarios to support decisions for military logistics. Respondents E2 and E3 also quoted that there are opportunities to develop tools for making risk evaluations based on the different cost scenarios. However, E3 was positive on saying that: (i) considering current military profile for those who take decisions at this level, they would hardly believe in this type of computer technology for such a role; (ii) to use this type of system would be necessary a skill that it is not a military training priority; and (iii) the development of this type of system would seldom be a priority for the military, as budget is tight and there are more important issues to deal with. Therefore, is shows that there are strong cultural issues related to the adoption of CCBTS for military supply chain logistics.

6.4 Locating Troops and all Military Facilities

This factor involves planning to assure that all military facilities are settled in the AOO for the military troops and equipment to arrive. Planning tasks in this factor involve three different areas of expertise, that are (i) military strategy and operations for accessing and protecting the AOO, (ii) engineering for defining best areas for locating and moving military forces, and (iii) biological, environmental and health expertise for identifying sanitation needs. Actually, all respondents were experts on aspects of military operations and none had expertise on the issues (ii) and (iii). For instance, E1 and E3 commented that is every day more common for the military to contract civil third parties for tasks that require expertise that are hardly found on the military, such as for engineering and health aspects. Actually, both E1 and E3 have been involved with military operations that used civilian contractors for both, engineering and health CSS. Table 3 shows a summary of the results for training the key tasks associated with locating military forces in the AOO and indicates that, following respondents opinions, this factor could hardly benefit from CBTS.

Table 3 – CBTS for locating military facilities

Locating Troops and all Military Facilities	E1		E2		E3	
14. Identify all actual or potential conditions that can cause injury, illness, or death to personnel; damage to or loss of equipment or property; or mission degradation.	N	N	N	N	N	N
15. Assess potential hazards and evaluate probability, severity and level of risk for each one identified.	N	Y	N	Y	N	N
16. Develop, implement and inform personnel about risk control measures (administrative and physical) and how each will be implemented and monitored.	N	N	N	N	N	N
17. Supervise, manage and evaluate the effectiveness of the established site controls.	N	N	N	N	N	N
18. Management practices for eliminating inefficiencies to optimize the use of all site resources.	N	N	N	N	N	N
19. Define and maintain sanitation needs and final deposition for dejects.	N	N	N	N	N	N
20. Develop a site-specific sampling plan to define a collection of data for defining what substances to look for and sampling protocols.	N	N	N	N	N	N
21. Defining living, working and storage areas (fuel, arms, generators, waste management facilities, wash racks) along the base camp.	N	Y	N	Y	N	Y

For instance, 6 out of 8 variables (14, 16, 17, 18, 19 and 20) have been pointed out as not present on current military training and neither is capable of benefiting from CBTS technology. Actually, only variable 21 was pointed out by all respondents as able to benefit from CBTS with visualization tools. For instance, E2 commented that some combat strategy computer games could help to improve the skills of logic reasoning required from military logisticians. E2 also quoted that there are some computer-based simulation tools, mostly applied for industrial modelling and optimization, which are also applied for military logistics, though it is still difficult to find. Military uses for simulations are often applied for building scenarios and

evaluating outcomes for predicting CSS effectiveness. However, none of the respondents has ever had access to those systems. On the other hand, all respondents indicated that there might be an opportunity for developing computer-based applications for training with task 21.

As a general comment for this factor, the respondents did not show knowledge on current computer-based applications for training for the key tasks required for planning to locate and transport military facilities in the AOO. Although the respondents are all experienced with military logistics practices and training, they all quoted that they are not familiar with the training practices in different countries and military institutions. Actually, that position was expected, since there are many military issues that are kept in secret, especially those that can represent strategic aspects that could be used to provide competitive advantage.

6.5 Transportation Resources and Paths to Follow

At this moment, after interviewing about the 3 other factors with the same questions for each variable, the respondents were well acquainted with the research objectives and the type of comments they should provide. They were also aware with the objective of identifying applications for CBTS technology for military supply chain logistics. Table 4 shows a summary of the answers provided by the interviews and, as a general comment, this factor is the one pointed out with the highest potential to benefit from CBTS technology.

Table 4 – CBTS for planning military transportation.

Locating Troops and all Military Facilities	E1		E2		E3	
22. Access the combat area and entry points (air, sea, roads, etc.)	N	Y	N	Y	N	Y
23. Movements of operation across the area of operations while supporting the mission	Y	Y	N	Y	Y	Y
24 Road construction (including needs for drainage, bridges, and flooding threats)	N	N	N	N	N	N
25. Rotation and redeployment of military forces	N	N	N	N	N	N
26. Planning for recovery and evacuation procedures	Y	N	Y	N	Y	N
27. Site Closure and return of all troops and equipment	Y	N	N	N	Y	N

Actually, the respondents indicated that 4 of the 6 variables in the transportation factor could benefit from CBTS. Moreover, the two variables indicated as not benefiting from CBTS (24 and 25) were pointed out as requiring specific knowledge about engineering (24) and psychology of human behavior (25), and though important for the transportation factor, they are not specific for military logisticians. However, all other 4 variables (22, 23, 26 and 27) were indicated as with potential to benefit from CBTS. For instance, for the variable 22 all said that there are computer images helping training for military combat strategy, but not for military logistics. Actually, military logisticians use the images from the combat strategy to plan task 22, but there is no specific CBTS to help training in this logistic task. The same situation occurs for the variable 26 as the planning for recovery and evacuation uses the same images that military strategists use for combat in the AOO. E1 and E3 also quoted that combat strategists have to provide military logisticians with standard documents and reports that would be easier to understand if provided with 2D and 3D images and CBTS technology. Therefore, this factor was pointed out as the one that could benefit the most from CBTS.

7.0 CONCLUSIONS

This research work was conceived from an idea that came from a professional with experience on computer-based military training, who engaged two other professionals, one experienced with military logistics and operations, and another with experience on academic research in IT business and management. Thus, this research work was settled with the objective of analyzing priorities and the role for CBTS on military supply

chain logistics. This objective has been achieved and the result is reflected on the development of the research instrument, which lists the most important tasks for planning military logistics. The instrument was first developed from a literature review and further validated with the respondents opinions taken from the interviews.

This work had also specific objectives, such as of identifying the current state of the art of training for military supply chain logistics and the role of CBTS in this field. Both objectives were achieved and results showed that this skill is currently acquired mostly by practical experience in the field and traditional classroom teaching. The work also showed that there is not a clear pathway for military personnel to achieve a position of a high ranked military in the field. As commented in the interviews, there are decisions that could be made for those who are willing to follow a carrier in the military logistics. However, there is little incentive for the military personnel to follow this carrier, which is even seen as a non-glory carrier path. However, there was also a comment in an interview that some countries motivate just the most gifted military recruits to follow this carrier path. Therefore, as a conclusion about how to become a high ranked military logistician, the answer is that it comes from "being at the right place, at the right moment and with the right knowledge". However, all respondents agreed that strategy computer-games, such as Age of Empires, Civilization, Command and Conquer, Forge of Empires and SimCity could help to develop reasoning skills that are part of the work as a military logistician.

Though the respondents are very experienced with military logistics, none was experienced with current CBTS technology. Therefore, when question (iii) was asked (what is the role of CBTS to improve skills for planning this task) they all have showed difficulties to answer, and that happened for all 27 variables. They all have only heard about CBTS for military applications, such as to predict the impact of nuclear attack on a particular place, for modelling movements in a particular AOO and to predict different outcomes for planning combat strategies.

Currently, military training for supply chain logistics is mostly provided by traditional classroom learning with lectures from experienced logisticians. The teaching practices are mostly based on previous experiences of military missions and analyzing successful and unsuccessful supply chain operations. As part of the open and informal interviews, some of the respondents were asked about the value of this education, since logistics, military equipment and IT resources are evolving every day, as well as the type of military missions, which are mostly unique. Though all respondents agree that there might be a gap between past and current military supply chain operations, the principles and reasoning involved are still an issue that is important to acquire. However, all agree that cost is currently a major issue on military logistics and all plans for CSS must strongly consider it.

Although current computer graphics and simulation technology have been successfully applied for several training, education and entertainment activities, the respondents were unanimous on reporting that it is still not applied for planning military supply chain logistics. They were also not secure on indicating that computer simulation could play an important role for improving skills for planning military logistics. Reasons behind it can range from the respondents profile, as they were all not very familiar with current CBTS, neither with computer-based training games and applications. However, they all agreed that there should be more for them to learn about CBTS to provide a more accurate answer on the issue to assure that it could help improving skills for military logisticians.

As future developments for this research, there should be interesting to carry out a focus group interview with military logisticians together with CBTS experts. It would allow them to collaborate matching two points of view about the state of the art of this technology and the role it could play for education with military supply chain logistics. Experts in the business area of military training could also be heard to identify whether it is worth developing CBTS tools for teaching military logisticians, as well as about the possibility to get financial support to develop applications.

As a transversal research work, the results taken from the interviews represent the viewpoint of these respondents on a specific moment in time. However, the same research instrument cam be used for further research and that must be seen as the major contribution from this work. Military logistics is often referenced as an unstructured task that involves many different activities and requires empirical knowledge from fielded operations that cannot afford bad decisions. Therefore, the research instrument could work as an opportunity to structure the knowledge on military supply chain logistics and continuously evaluate training conditions. CBTS can also play a role on embodying knowledge from previous and innovative cases for simulating results of decisions of military supply chain logistics.

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Appendix 1

Evaluation of Computer-Based Training and Simulation Technologies for Military Supply Chain Logistics

For all following items, please answer with **your perception** according to 3 aspects:
- how is the **current training** approach for providing that skill;
- in case **training can be improved**, how do you thing it should be done;
- the **role of computer-based training** and simulation for improving that skill.

I. Respondent Profile

Military Rank:

Current Status:

Time of experience with military logistics:

Time of experience with training for military logistics:

II. Please answer with your perception about training for the following aspects of military logistics

Mission Analysis - aims to identify key tasks required or implied to accomplish the military mission.
Provide a description of the military operation to be accomplished
Identify key tasks required to accomplish it and breakdown the needs in a plan
Define the skills necessary to accomplish the mission
Prepare staff estimates to accomplish the mission, defining roles and responsibilities for all;
Evaluate key factors for the military logistics structure
Identify logistics constraints (costs, personnel, equipment, rules of engagement)
Set up the logistics planning for staff integration (nations, actors, commanders)
Develop the mission planning guidance
Communicate actors about the logistic concept (movements, supplies, medical, etc.)
Comments:

Combat readiness level - involves planning to identify and manage supplies for arming, fuelling, feeding, repairing and clothing the military forces, to assure an efficient use of resources to accomplish the mission.
Define strategic lines of communication and procedures to locate and discipline wired/wireless communications
Identify host nation support
Define Class I (rations), Class II (general supply) and all necessary support to assure subsistence for the military forces;
Take decisions over role-effectiveness vs cost effectiveness combat support
Comments:

Locating troops and all military facilities - involves an evaluation of initial environmental conditions and access the overall site sustainability for defining the most suitable locations for base camps that maximizes the use of all military resources (multinational efforts, hosting nation, contracted sources, etc.).
Identify all actual or potential conditions that can cause injury, illness, or death to personnel; damage to or loss of equipment or property; or mission degradation.
Assess potential hazards and evaluate probability, severity and level of risk for each one identified.
Develop, implement and inform personnel about risk control measures (administrative and physical) and how each will be implemented and monitored.
Supervise, manage and evaluate the effectiveness of the established site controls.
Management practices for eliminating inefficiencies to optimize the use of all site resources.
Define and maintain sanitation needs and final deposition for dejects.
Develop a site-specific sampling plan to define a collection of useful data for defining what substances to look for and sampling protocols.
Defining living, working and storage areas (fuel, arms, generators, waste management facilities, wash racks) along the base camp.
Comments:

Transportation resources and paths to follow - involves planning for transporting all military resources and paths to follow
Access the combat area and entry points (air, sea, roads, etc.)
Movements of operation across the area of operations (AOO) while supporting the mission
Road construction (including needs for drainage, bridges, and flooding threats)
Rotation and redeployment of military forces
Planning for recovery and evacuation procedures
Site Closure and return of all troops and equipment
Comments:

II. Evaluation of general research aspects

Please feel free to comment on the following issues
Ability of the research instrument to represent key aspects of military logistics
Language and structure of the instrument
General opinion on current IT for providing training on military logistics
General opinion on current IT systems and devices for helping skilled military logisticians to make decisions
General opinion about the future on training for military logistics
Comments: