

Systems literacy amongst air force logisticians in Nigeria

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Abstract

Purpose – The purpose of this research is to assess the current level of systems literacy of air force logisticians in Nigeria.

Design/methodology/approach – This research undertook an assessment of the knowledge of air force logistics officers on systems thinking with the aid of a qualitative questionnaire. The questionnaire featured questions on the level of literacy and application of systems thinking by air force logisticians in Nigeria.

Findings – The research finds that the majority of the air force logistics officers have very low levels of knowledge and training in systems thinking.

Originality/value – The research is a unique effort to ascertain the level of systems thinking literacy and training in air force logistics in Nigeria. The study presents a baseline and justification for intervention through an improvement of the logistics curricula used in air force training institutions in Nigeria.

Keywords Systems thinking, Defence logistics, Systems literacy, Air logistics operations

Paper type Research paper

1. Introduction

Logistical activities have been practised since the evolution of organised warfare. In ancient times, armies were sustained in battlefields through a well-organised scheme of food and forage supplies. In the nineteenth century, Napoleon established a wholly militarised train service that guaranteed the supply of varying logistical requirements (Herberg-Rothe, 2007). The cruciality of logistics in military operations has remained uncontested throughout the centuries. With the increasing complexity of military operations, the importance of logistics in the military became prominent. Countries around the world standardised logistics in their respective armed forces by creating logistics branches or arms. The UK Ministry of Defence formed the Defence Logistics Organisation and tasked it with the role of supporting the armed forces in operations (Anand, 2001). A similar role is performed by Defence Logistics Agency in the US, National Logistics Cell in Pakistan, Armed Forces Logistics Authority in Egypt and the Logistics Department of the Chinese Armed Forces (Smith, 2018). In Nigeria, each of the three services of the armed forces, namely army, navy and air force, has a logistics branch.

In discharging their duties, most of the logistics branches established by several armed forces had to contend with complex intra- and inter-level coordination. This necessitated the use of systems thinking in managing the complexities of logistics. The application of systems thinking to logistical activities has proven useful in several operations, such as Operation Iraqi Freedom, which, according to US General JE Wissler, owed its success to a deliberate systemic approach (Behl and Ferreira, 2014). Employed in military logistics, systems thinking allows for multiple perspectives and consideration of ambiguities and uncertainties. Systems thinking also guides complex decision-making and recognition of interconnections



within logistical systems. The adoption of systems thinking in military logistics is thus invaluable. However, systems thinking amongst military logisticians in Nigeria, especially in the air force, is not evident. Increased military operations, ranging from peacekeeping to counterterrorism, has exposed a gap in the management of logistics amongst air force personnel. In a recent counterinsurgency operation in north-eastern Nigeria privy to the author, the logistics plan for a new forward operational base omitted some critical building services and installations. These omissions undermined the onset of operations and personnel welfare in the base. Although the location of the operational base in a highly volatile theatre might have constrained logistical planning, the application of systems approach could have precluded such costly errors. However, the use of the systems approach in logistics operations depends largely on the extent to which logistics officers are systems literate. Establishing the degree of systems literacy amongst air force logisticians in Nigeria will, therefore, provide a basis for possible intervention.

This paper assesses the systems literacy of air force logisticians in Nigeria with a view to establishing a baseline for intervention. The study administered a survey to commissioned air force logistics officers in Nigeria deployed in four air force specialties, namely procurement, supply, works and services. The assessment of systems literacy questioned what the officers know about systems thinking and whether systems thinking was a taught course in any logistics training in the air force. The paper provides an overview of systems literacy and air force logistics in Nigeria. Thereafter, the methodology and findings of the study are detailed before highlighting some limitations of the study and conclusions.

1.1 Systems literacy

The word “system”, based on available records, began to appear in English writings in the early seventeenth century. Gradually, the term gained literary ubiquity occurring, for example, nearly 100 times in *The Age of Reason* (1794) – the seminal work of Thomas Paine. The 1600 and 1700s denotation of system has been somewhat retained in modern usage. System is conceived as a collection of interconnected parts working towards a common goal. Systems scholars stress that the value added by the system as a whole, which transcends the independent contribution of its parts, is a consequence of the relationship between the parts. With the rise of system concepts, arose the notion of systems thinking. Senge defines systems thinking as a “framework for seeing interrelationships rather than things [and] for seeing patterns of change rather than static snapshots” (Senge, 2006, p. 69). Systems thinking calls for a conceptual departure from the conventional approach to problem-solving, which has been reductionist and mechanistic. The need to teach and learn about systems and systems thinking engendered the idea of systems literacy.

Systems literacy has no definitive characterisation. There are arguably as many definitions of systems literacy as there are systems scholars. Taylor *et al.* (2020) described the path to becoming a systems thinker as involving three levels, namely sensibility, literacy and capability. According to these researchers, an individual attains systems sensibility by being aware of systems. Correspondingly, knowledge of systems gives rise to literacy, while understanding of systems yields capability. However, for the purpose of this paper, systems literacy is understood as an ability to demonstrate a knowledge of systems and to communicate in systems language. In order to appreciate systems literacy, it is imperative to devise a means of gauging it.

Several studies have been undertaken to measure systems literacy. These studies include assessments of systems thinking knowledge and evaluation of an appropriate pedagogy for systems thinking learning. With respect to knowledge assessment, Connell *et al.* (2012) evaluated the systems thinking competence of two groups of students in the US. The study proceeded as a mixed research employing both qualitative and quantitative techniques to

collect pre-intervention and post-intervention data. Using the complex problem of sustainability as a premise, the researchers assessed the systems thinking competence of the students in terms of holistic thinking and conflict resolution. With the aid of a rubric featuring a Likert scale of 0–5, the students were evaluated based on their responses to the challenges of sustainability. The study revealed that prior to any teaching interventions, the students had an unsophisticated knowledge of systems thinking. However, as the students underwent weeks of lessons on systems thinking, their skills and competencies in holistic thinking and conflict resolution improved remarkably. Thus, the researchers concluded that systems thinking skills could be gained through effective systems thinking education.

Seeking an efficient means of assessing systems literacy, [Plate and Monroe \(2014\)](#) devised a structure based on the levels of systems thinking skills proposed by [Hopper and Stave \(2008\)](#). The levels include recognising interconnections, identifying feedback, understanding dynamic behaviour and differentiating types of variables and flows. Others are using conceptual models, creating simulation models and testing policies. An interesting consensus on this taxonomy is that some skills are more fundamental than others and should be learnt before others ([Plate and Monroe, 2014](#)). Therefore, the first three skills can be described as basic, whilst the next two skills as intermediate and the last two as advanced. However, it is instructive to note that the aforementioned assessment structure is most appropriate in situations where some systems thinking presence has already been established. In this context, it is intelligible to discuss and evaluate basic, intermediate and advanced systems thinking skills. Hence, studies intending to discover the competence level of systems thinking amongst organisational staff could employ such a taxonomy-based model.

An effective means of determining the baseline systems literacy in organisations with an indeterminate presence of systems thinking is to sample the opinions of the stakeholders in such organisations. [Tuddenham \(2017\)](#) proposed a simple enquiry using a series of open-ended questions. It may be useful to ask the stakeholders what they know about systems thinking and whether they apply the systems approach to their activities. The stakeholders are better placed to provide information on the extent to which systems thinking knowledge and application are prevalent in their organisation. Therefore, using the open-ended questioning approach would enable a researcher to gauge the level of systems literacy and awareness within a community. This information is useful for subsequent intervention plans as well as further studies.

1.2 Applying systems thinking to defence logistics

Systems thinking has been applied in addressing complex systems. Since the rise of systems thinking concepts, ill-structured problems have been approached with the aid of the systemic view. Systems thinking scholars argue that the systems approach is effective in appreciating and managing a range of socio-technical systems, such as policing, health care, climate change and even terrorism. The application of systems thinking on social problems has been cited in a number of studies. Sequel to the Twin Tower attacks in the United States, six members of the Anti-Terrorism International Working Group convened a panel at the International Council on Systems Engineering secretariat in Las Vegas. The outcome of the convention was a publication on the role of systems thinking concepts in combating terrorism ([Mackey et al., 2003](#)). Given the versatility of systems thinking notion, the idea of employing it in logistics management was almost inevitable.

[Ho \(1997\)](#) mentions areas in which systems thinking can be applied to logistics management. According to Ho, systems thinking can be employed to reconceptualise the logistics process as a system. Given the complexity of logistical activities, the practice and underpinning theories of logistics could be synthesised into a systemic process. This would facilitate the use of systems thinking concepts to address various logistical issues.

Additionally, Ho suggests that the systems approach could be applied to the logistics problems of destination, demand, distance and duration, the so-called 4Ds. Whilst destination deals with the environment to which supply is delivered, demand determines the quantity or volume of support needed. Distance covers both length and capacity of supply routes, whilst duration deals with the length of the supported activity. Systems thinking ideas of emergence, holism and interrelationships can be used to view these 4Ds as a systemic process.

The application of systems thinking to defence logistics rationally follows on from the adoption of the concept in general logistics management. Notwithstanding the peculiarity of defence logistics, it can benefit immensely from the application of systems thinking. An example of the systems approach in defence logistics is the system and subsystems relationship principle espoused in the UK's Joint Defence Publication (JDP4-00) on Logistics for Joint Operations. Systems thinking ideas feature prominently in the JDP. In the discussion of logistics decision support in the document, the notion of subsystems interaction is employed to underscore the interconnectedness of the numerous components forming the logistic decision support system. Some of these elements include NATO Logistics Functional Area Services, Management of the Joint Deployed Inventory and Joint Asset Management and Engineering Systems. Others are Air Core Passenger Movements System and Base Warehouse Inventory Management System. Using the systems outlook to analyse the interrelationship of these subsystems leads to a deeper and broader appreciation of the logistical situation, which ultimately contributes to high quality defence logistics decision.

1.3 Air force logistics in Nigeria

Logistics in defence evolved from the need to sustain military operations across operational theatres. However, there are peacetime and war-time logistics activities. Air force logistics activities in Nigeria can be traced to the creation of the air force in 1964 (NAF, 2020). Since its establishment, the air force has been exposed to the need for logistics arrangements in its various air operations. Three years after its creation, the air force was involved in the Nigerian Civil War (1967–1970) which required intensive logistics (NAF, 2020). At the time, the air force had a few aircraft in its inventory, but as the war progressed, some fighter aircraft, such as MiG 15 and MiG 17 were acquired to fast-track the process of ending the war (Otu Offiong Duke, 2019). In all these activities, the cruciality of logistics in air warfare became evident to the air force leadership.

The incipient logistical arrangement in the air force was in the form of a support command. A logistics group under the support command was tasked with aircraft maintenance, supply and armament (Oshoniyi, 2005). The expansion of the air force in the 1980s necessitated the upgrade of the logistics group to a logistics command, which was established in 1984 (NAF, 2020). The current air logistics organisation is based on a composite structural arrangement within which all components of air logistics support air operations at all levels of command. However, the increased demand of air operations over the years has consistently challenged the ability of logistics to sustain air operations effectively and efficiently. The current air force leadership seeks to position the force for a sustained employment of air power to meet joint national defence imperatives as well as provide swift response capabilities for internal and emergency security challenges. In line with this vision, the logistics branch of the air force is constituted into four directorates, namely works, supply, procurement and services (NAF, 2020).

The procurement directorate is responsible for the central coordination of procurement activities in the air force in concert with national procurement laws. The department ensures that processes of awarding and execution of contracts are observed diligently (NAF, 2005). The supply directorate is tasked with air force supply activities, including formulation and

implementation of policies, manpower and inventory management (Oshoniyi, 2005). Other functions of the directorate are material budgeting, general supply administration and provision of petroleum, oils and lubricants. It also liaises with the Nigeria Customs Service for the release of air force shipments from overseas vendors (NAF, 2005). The works directorate is tasked with devising policies on infrastructural development, design, construction, maintenance and project supervision. Works projects in the air force typically feature construction of residential, administrative, operational and recreational facilities (NAF, 2005). The services directorate performs the logistics functions of airfield maintenance, rapid runway repair, hangar provisions and general building services.

2. Methods

2.1 Sample size

The survey population in this study was the air force logistics community in Nigeria ($n = 122$). Using a 95% confidence level and a 5% margin of error, a sample size of 92 respondents was calculated. However, the sample size that was eventually achieved was $n = 105$. This sample was made up of procurement personnel ($n = 19$), supply personnel ($n = 34$), works personnel ($n = 31$) and services personnel ($n = 21$). The respondents were exclusively commissioned officers of the air force in Nigeria under the logistics branch. The demographic characteristics considered in the study were length of service, educational qualification and rank. Thirty-two of the participants had spent between 6 and 10 years, whilst 11 respondents had served in the logistics branch for 20 years and above. It is noteworthy that 25 officers had the least service years of between 1 and 5 years. In the same vein, the educational qualification of the participants was obtained. Two participants from the procurement and supply directorates had a PhD, whilst the majority of the respondents ($n = 75$) had a bachelor's degree. With respect to the military ranks, almost half of the respondents ($n = 47$) were flight lieutenants. There were also five group captains and three air commodores amongst the respondents. It is noteworthy that this array of respondents within the logistics community of the air force in Nigeria offered an opportunity to obtain varied views on systems thinking. [Appendix 1](#) shows a summary of the sample information.

2.2 Data collection

Data were collected qualitatively using questionnaires administered to the logistics community in the air force of Nigeria. Five open-ended questions featured in the questionnaire bordering on systems thinking knowledge and application. There were questions on personal details of respondents to establish their qualification and other demographic characteristics. The open-ended questioning approach was intended to allow the free expression of thoughts without any restrictions. At least one question was posed to elicit an appropriate response for each required data. For example, to sample the knowledge of the logistics officers on systems thinking, the questions “*What do you know about systems thinking?*” and “*Is systems thinking a course you were taught in any of your logistics training since joining the air force?*” were posed. The questionnaire was in the form of an online survey whose link was shared on several media platforms for access by the respondents. The online survey had a preamble that emphasised the voluntariness and anonymity of the responses. [Appendix 2](#) is a sample of the questionnaire.

2.3 Data assessment

NVivo11 Pro was used to analyse the data qualitatively. The software comprises many features that facilitate the management of complex and unstructured data. It is easy to organise, analyse and draw insights from qualitative data with the aid of NVivo11.

The software aids researchers in theme, case and relationship coding which are invaluable to qualitative data analyses. The software can also be used to determine frequency of mentions or appearances of words within a dataset. The data collected from the qualitative questionnaires in the present research were imported into the NVivo software as online documents. These electronic materials were closely scrutinised to identify themes as well as descriptive statistics. The responses to each prompt on the questionnaire were recorded and disaggregated across the various categories of the respondents. These results were subsequently represented on a frequency distribution table.

3. Findings

3.1 Outcome of systems literacy assessment based on Q2

The systems thinking knowledge of the air force logistics officers was assessed based on Q2: “What do you know about systems thinking?” The response of the participants to this question is summarised in Table 1. From the table, the majority of the respondents (75%) admitted knowing nothing about systems thinking. Disaggregating the data by directorates showed no significant differences, although supply and procurement directorates reported relatively higher percentages of systems knowledge. The reason for the comparatively better performance of the two directorates is not evident, especially given the high percentages of the procurement and supply personnel who admitted knowing nothing about systems thinking. This means that there is a general lack of knowledge about systems thinking across logistics personnel in the four directorates of the air force logistics branch. However, systems knowledge of the air force logistics officers differed based on military ranks as 60% and 100% of group captains and air commodores, respectively, indicated some knowledge of systems thinking. The indication of systems knowledge by the senior officers could be due to a possible encounter of systems ideas at senior command and war colleges or during strategic decision making in command roles. In terms of qualification, systems knowledge was

Q2. What do you know about systems thinking?		Frequency (Nr)			Frequency (%)	
		Nothing	Something	Total	Nothing	Something
Directorate	Procurement	14	6	20	70	30
	Supply	22	12	34	65	35
	Works	26	5	31	84	16
	Services	17	3	20	85	15
Total		79	26	105	75	25
Rank	Flying officer	13	2	15	87	13
	Flight lieutenant	37	10	47	79	21
	Squadron leader	17	7	24	71	29
	Wing commander	10	1	11	91	9
	Group captain	2	3	5	40	60
	Air commodore	0	3	3	0	100
Total		79	26	105	75	25
Qualification	BSc	60	15	75	80	20
	MSc	17	11	28	61	39
	PhD	2	0	2	100	0
Total		79	26	105	75	25
Length of service	1–5 years	22	3	25	88	12
	6–10 years	21	11	32	66	34
	11–15 years	20	5	25	80	20
	16–20 years	7	5	12	58	42
	21 years and above	9	2	11	82	18
Total		79	26	105	75	25

Table 1.
Summary of
responses – systems
thinking knowledge

reported at somewhat low levels, with master’s degree holders reporting the highest knowledge. Furthermore, across the length of service, officers who spent 6–10 years and 16–20 years reported high levels of systems knowledge, which is consistent with the data based on ranks. Overall, the finding indicates that there is a widespread lack of awareness of systems thinking amongst air force logistics officers in Nigeria.

The finding of a general lack of awareness of systems thinking amongst the logistics officers is congruent with the work of Connell *et al.* (2012). Similar to the present study, Connell *et al.* discovered an unsophisticated level of systems thinking knowledge amongst a sampled student community in the US. The similarity between the air force logistics community in Nigeria and the student community in the work of Connell *et al.* is the absence of an intervention prior to the assessment. This means that the likelihood of an uninitiated community to be unaware of systems thinking is high. In the case of the air force logistics officers, the claim by the majority of the officers to know nothing about systems thinking is consistent with a community that has not been exposed to systems thinking. It is particularly interesting that the lack of exposure to systems thinking pervades all the categories of the respondents including directorate, rank and educational qualification. Consequently, it is imperative that systems thinking is included in the training of air force logistics officers to expose them to the high-end skills of the systemic approach.

3.2 Outcome of systems literacy assessment based on Q3

The responses of the participants to Q3 are presented in Table 2. The prompt for the response was “Is systems thinking a course you were taught in any of your logistics training since joining the air force?” From the table, an overwhelming majority of the respondents (97%) stated that they had not been taught systems thinking since joining the air force. This response did not vary across the categories of the participants. There were no significant differences in terms of

Q3. Is systems thinking a course you were taught in any of your logistics training since joining the air force?		Frequency (Nr)			Frequency (%)	
		No	Yes	Total	No	Yes
Directorate	Procurement	18	2	20	90	10
	Supply	33	1	34	97	3
	Works	31	0	31	100	0
	Services	20	0	20	100	0
Total		102	3	105	97	3
Rank	Flying officer	15	0	15	100	0
	Flight lieutenant	46	1	47	98	2
	Squadron leader	22	2	24	92	8
	Wing commander	11	0	11	100	0
	Group captain	5	0	5	100	0
	Air commodore	3	0	3	100	0
Total		102	3	105	97	3
Qualification	BSc	74	1	75	99	1
	MSc	26	2	28	93	7
	PhD	2	0	2	100	0
Total		102	3	105	97	3
Length of service	1–5 years	25	0	25	100	0
	6–10 years	31	1	32	97	3
	11–15 years	23	2	25	92	8
	16–20 years	12	0	12	100	0
	21 years and above	11	0	11	100	0
Total		102	3	105	97	3

Table 2.
Summary of
responses – systems
thinking training

directorates, rank, length of service and educational qualification of the sampled air force logistics officers. This implies that the training of air force logistics officers in their various directorates, from officer cadets to full-fledged commissioned officers, does not feature systems thinking. Furthermore, the admission of both long-serving and newly commissioned officers to not receiving systems thinking education indicates an absence of the course in air force logistics training programmes. This finding is remarkable, given that systems thinking is internationally recognised as important to military logistics (Mackey *et al.*, 2003).

The finding of an absence of systems thinking education in the training of air force logistics officers contrasts with the works of Benedek and Horváth (2016). These researchers conducted an extensive study of logistics organisations and discovered a fair effort at featuring systems thinking in the curriculum of trainee logisticians. Additionally, Alexander (2007) found the existence of some level of systems approach in his study of the US Defence Acquisition System traceable to the training of logistics personnel. The absence of the teaching of systems thinking to air force logistics personnel is, thus, contrary to global best practice given the importance of the discipline to logistics practice. Therefore, it is essential for the air force to introduce systems thinking as part of the training of logistics officers in order to capacitate them to aptly manage the complexity of air logistics and to conform to global best practice.

4. Limitations

One of the constraints of the study borders on the measure of systems literacy based on the open-ended questioning approach. The two questions posed to respondents in the study could elicit inexhaustive responses. This is because systems tools, such as lifecycle assessment and user requirements might be taught without the title of systems thinking explicitly indicated. It is, thus, possible for respondents to be aware of such concepts without necessarily linking them to systems thinking. Hence, the framing of the questions exclusively on systems thinking might have engendered the high responses of unawareness of the discipline amongst the air logistics officers. However, if it was the case that the respondents were aware of systems concepts but not systems thinking, then such knowledge is inadequate. Moreover, given the overarching aim of the research to assess the baseline systems literacy of the air force logisticians in Nigeria, the questioning approach of the study is still valid.

Another limitation of the study is the failure to investigate the presence of systems thinking in air force logistics training curriculum and other relevant publications of the logistics branch. Such an investigation could have contributed to data triangulation that may provide additional insights into the findings of the study. However, given time constraints, such an examination is proposed as a further study. Such a study would indicate the areas within the logistics training curriculum that could be integrated with systems thinking concepts.

5. Conclusions

The baseline systems literacy of air force logisticians in Nigeria was assessed based on an enquiry about the officers' awareness of the discipline and whether it is taught during their logistics training. Responses generated from these enquiries were analysed and represented in the form of descriptive statistics. The analyses yielded a number of findings as presented and discussed in this paper. Firstly, the air force logistics officers in Nigeria were discovered to possess low knowledge or awareness of systems thinking. The majority of the logistics officers indicated knowing nothing about systems thinking. This lack of awareness of systems thinking cut across the various categories of the data including directorate, rank, qualification and length of service with some nuances. Secondly, there was evidence that systems thinking was not taught in any of the logistics training undertaken by air force logistics officers in Nigeria. The overwhelming majority of the logistics officers admitted that

they were not taught systems thinking in the course of their logistical training in the air force. On the whole, the findings highlighted in this paper indicate the need to enhance the systems literacy of the air force logisticians in Nigeria, possibly through an intervention in the logistics training curriculum.

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Appendix 1

Breakdown of survey population			
Serial (a)	Directorate (b)	Number of personnel (c)	Remarks (d)
1	Procurement	22	Represents the number of commissioned officers under procurement directorate from the rank of flying officer and above as at the time of the study
2	Supply	40	Represents the number of commissioned officers under supply directorate from the rank of flying officer and above as at the time of the study
3	Works	35	Represents the number of commissioned officers under works directorate from the rank of flying officer and above as at the time of the study
4	Services	25	Represents the number of commissioned officers under services directorate from the rank of flying officer and above as at the time of the study
<i>Total</i>		<i>122</i>	

Demography – Length of service		Frequency				
Demography – Length of service		Procurement	Supply	Works	Services	Total
Directorate						
Length of Service	1–5 years	3	14	4	6	25
	6–10 years	7	8	14	3	32
	11–15 years	6	5	7	7	25
	16–20 years	2	3	5	2	12
	21 years and above	2	6	1	2	11
<i>Total</i>		<i>20</i>	<i>36</i>	<i>31</i>	<i>20</i>	<i>105</i>

Demography – Educational qualification		Frequency				
Demography–education		Procurement	Supply	Works	Services	Total
Directorate						
Qualification	BSc	12	27	25	13	75
	MSc	7	8	6	7	28
	PhD	1	1	0	0	2
Total		20	36	31	20	105

Table A1.
Summary of sample
information

Appendix 2
Assessment of systems literacy

Section A: Demographic Questions

- *1. a. Name: b. Rank: c. Directorate: d. Qualification:
e. Length of Service Years:

Section B: Systems Thinking Questions

- *2. What do you know about systems thinking?
- *3. Is systems thinking a course you are/were taught in any of your logistics training since joining the Nigerian Air Force?
- *4. Do you have any other comments?

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