Profile of M&S Research Published in the Journal of Defense Modeling and Simulation

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Abstract: The *Journal of Defense Modelling and Simulation (JDMS)* publishes peer-reviewed articles in M&S in the application area of military and defense. We profile literature published in JDMS from 2012 to 2016. Over 150 contributed and special issue papers appeared in a total of 20 issues of the journal during this period. Our analysis includes the contribution of the authors and their respective universities/departments using measures such as total papers published, count of unique authors in an institution, and authors with the most number of publications; it recognizes the geographical diversity of the authors' affiliations by presenting country-specific data. The analysis takes into account the contribution made by researchers, practitioners and military personnel and their relative seniority. We identify the most cited papers and present an aggregate analysis of contribution by research field. We also identify the top funding sources that are acknowledged by the authors. Our findings show the predominance of US in research related to defense M&S. This includes the US-based affiliation of a significant proportion of JDMS authors and the concentration of US-specific bodies that fund defense-related research.

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1. INTRODUCTION

The *Journal of Defense Modelling and Simulation: Applications, Methodology, Technology* (henceforth referred to as *JDMS*) is published by the *Society for Modeling and Simulation International (SCS).* It is a society that is devoted to furthering the field of M&S, including dissemination of scholarly articles through its two peer-reviewed publication outlets, namely, *JDMS* and *Simulation: Transactions of the Society for Modeling and Simulation International*. On the 60th anniversary year of the Society, a couple of authors of this paper took the initiative to prepare a profiling study of literature published in *Simulation: Transactions* from 2000-2010 [1] and further to present a co-citation analysis for the same journal [2]. They believed that, presenting a snapshot of literature was a *fitting tribute* to those "scientists and engineers, who had actively shaped and influenced the growth and development of SCS and continue to contribute to the theory, methodology, and applications of simulation science" [3].

Our paper for JDMS is written with a similar purpose in mind. It is, first and foremost, a paper that acknowledges, among other things, the contributions of the authors, their affiliated institutions and departments that have played a pivotal role in the development of M&S applications, methodologies and technologies for defense. Our profiling exercise is also an art of introspection as it facilitates the editors and readers to reflect on what the journal publishes and its evolution over the years [4]. For those new to this field, our article will allow them to quickly get up to speed with M&S research in defense. Finally, reviewing and profiling existing publications can help to identify currently under-explored research issues, and select theories, methods and techniques appropriate to their investigation. Examples of journal profiling studies include, (a) those conducted with relation to a particular journal, for example, profiling study of *Information and Management (I&M)* [5], *European Journal of Information Systems (EJIS)* [6], *Information Systems Frontiers* [7], *Journal of the Operational Research Society* [8], and *Simulation: Transactions of the SCS* [1], and (b) those that compare between journals, for example, *Management Information Systems Quarterly (MISQ)* and *I&M* [9], *MISQ* and *EJIS* [10], and *I&M, EJIS* and *MISQ* [4].

JDMS is a refereed archival journal that is devoted to "advancing the practice, science and art of M&S as it relates to the military and defense" [11]. The journal, which covers all areas of the military, is particularly receptive of papers that are on the practical aspects of M&S, rather than purely theoretical explorations. Indeed, it is stated in the aims and scope of the journal that its primary focus is to document, in a rigorous manner, technical lessons derived from practical experiences. The journal also publishes work related to the advancement of defense systems M&S application (e.g., warfighting, command and control, decision support, peacekeeping,

special operations, homeland security), methodology (e.g., simulation design techniques, scenario construction and federation construction process), and technology (e.g., simulation techniques, synthetic natural environment modeling and HLA). JDMS is a quarterly publication (4 issues a year) and is presently in volume 14 (as in 2017). The Editor-in-Chief of the journal is supported by two other Editors for Europe and Asia-Pacific region respectively, and an international team of Associate Editors and members of the Editorial Board. JDMS is archived in a new index by the *Web of Science™ Core Collection* called the *Emerging Sources Citation Index (ESCI)*, which is considered as high-quality, peer-reviewed publications of regional importance and in emerging research fields [12].

Having provided an overview of the journal, we now list the objectives which will define the variables for data collection and its subsequent analysis. Our objectives are, (a) to analyze authorship and identify authors with the most number of publications in the period considered in this study, (b) to determine the institutions, departments/research centers and geographical locations associated with the majority of publications, (c) to identify the most-cited papers through citation analysis, and (d) to identify the top funding organizations. The findings of the study will thus present a ranking of the most productive authors, institutions, etc.; however, we would like to voice a note of caution to the readers with regard to interpreting this data. It is important to emphasize that such findings should be regarded as indicative only of the journal's activity. This is because our journal-specific profiling exercise does not take into consideration several leading researchers, institutions and seminal research papers because they have not been published in this journal within the timeframe of the analysis.

The remainder of this paper is organized as follows. In the next section we present an analysis of scholarly content published in JDMS. This is followed by section 3 which describes the methodology that we employed to conduct the profiling exercise. Here we describe data that was captured, provide details on data cleaning/formatting and analyses this enabled us to perform. In section 4 we present the findings. Section 5 discusses the findings and is the concluding section of the paper.

2. ANALYSIS OF JOURNAL CONTENT

The period of review was from 2012 to 2016, both years inclusive. Thus, we undertook the review of 20 issues of the journal (Vol 9 – Issue 1 to Vol 13 – Issue 4). A total of 163 papers were published in this period, with an average of around 32 paper per year; the number of papers varied from a minimum of 28 in 2012 to a maximum of 36 articles in 2015 and 2016 (Table 1). It is to be noted that special issue guest editorials are not included in the count presented. Adding the 11 editorials with bring the count up to 174.

Table 1: Total number of papers published (2012-2016)

Year	#Papers
2012	28
2013	31
2014	31
2015	37
2016	36

JDMS provides the opportunity for researchers and practitioners to act as Guest Editors of Special Issues and over the years numerous special issues have been published. During the period analysis, a total of 11 special issues were published which accounted for a total of 60 papers – this represented approx. 37% of all articles published (Table 2). Seven of the eleven special issues also included regular papers, however, the count shown below is only for the special issue papers. There number of journal issues that were devoted to these special issues varied from year to year, for example, in 2012 (vol. 9) there were four special issues and in 2016 (vol. 13) there were none. The special issue topics demonstrate the traditional focus of the journal on practical aspects of defense systems M&S, e.g., three special issue related to unmanned and autonomous systems (2012, 2014 and 2015), homeland security (2014), warfare simulation (2012). A few special issues focusing on theory and methodology have also been published, e.g., methodologies and techniques for cyber defense (2012), verification, validation and accreditation (2013).

Table 2: Special issues and the total number of papers in each issue (2012-2016)

Year	Issue	Title of Special Issue	# Papers
2012	Jan-12	Intelligent Behaviors in Tactical Unmanned Systems	7
	Apr-12	Resuability, Interoperability and Composability in Air Warfare Simulations	4
	Jul-12	Cyber Defense: Methodologies and Techniques for Evaluation	5
	Oct-12	USMOS Conference: Recent Research on Defense	5
2013	Apr-13	Modelling and Simulation for NEC	5
	Oct-13	Verification, Validation, and Accreditation in Modeling & Simulation	6
2014	Jan-14	Intelligent Behaviours of Unmanned Systems (SPIE)	5

	Apr-14	Art and Science of Live, Virtual and Constructive Simulation and Intelligent Agents to Support Defense and Homeland Security Testing and Analysis	8
	Jul-14	Novel Approaches to Defense and Military Modeling and Simulation	4
2015	Jan-15	Fuel conservation and alternative energy in the Department of Defense	6
	Oct-15	Modeling & Simulation for Cyber Security of Autonomous Vehicle Systems	5

As we were reading through the issues, we realized that some journal page numbers were devoted to content which were not academic in nature (e.g., numbered blank pages, tables of content, call for papers). Further, there were errors in the numbering of pages between issues, e.g., vol. 9(1) ends with page 92 and 9(2) begins with 97. We decided to capture information on missing pages and the number of pages devoted to academic vs. non-academic content. For this analysis we categorized content into guest editorials, academic content and non-academic content.

- *Guest editorial* – articles written by the guest editor(s) of the special issue - we have one article for every special issue and none for regular issues.
- *Academic content* - regular and special issue articles
- *Non-academic content* – any content that is not a guest editorial, regular or special issue article – this includes numbered blank pages, tables of content, call for papers, advertisements, and one Editor's introduction in 12(3) by the current EIC.

Our analysis showed than a total of 146 pages (130 pages with non-academic content *plus* 16 missing pages) do not include scholarly content. Numbered pages with non-academic content thus represents approx. 6% of pages devoted to academic content, and this value rises to approx. 6.8% if missing pages are added to the calculation. Why is this value important? Journals act as an archival source of knowledge and it is the usual practice to allocate page numbers to articles (this may include editorials, special issue and regular articles, technical note, author response to comments, corrigendum); for content such as CFPs, advertisements and TOCs roman numerals and other form of numbering is generally used. Having non-academic content in the formal page numbering of a journal is not desirable for a number of reasons. It gives the wrong impression on the corpus of knowledge archived in volumes and issues of a particular journal. Further, this could be a source of confusion for those trying to identify the papers with the missing page numbers (as was the case with us!).

3. LITERATURE PROFILING METHODOLOGY

Five volumes of JDMS were made available to us. This represented the publication period from January 2012 until October 2016. From this source we gain a snapshot of the journal's evolution, as well as draw interesting conclusions about the last five years of research published through this outlet. For data collection we used Microsoft Excel. We created a new row for every paper-author-organization combination (this can be thought of as a composite primary key). In other words, one volume has several papers which may have one or more authors, each of who may one or more affiliations. In total we had close to 750 records and collected data, such as, year of publication, volume and issue, paper title, and several other variables. To help organize data collection, we divided the variables into three sections – *Journal Content, Authors & Institutions* and *Funding & Citation*. The data collection method for variables under each of these sections will be described below.

3.1 Data on Journal Content

Data captured in this section focuses on how the journal is put together and presents its academic content. We collect data on particular issues (special issue, regular issue or an issue featuring both regular and special issue articles), the papers published in these issues (guest editorial, special issue paper, regular issue paper or non-academic content), and finally the page numbers for every issue (e.g., first numbered page, last numbered page, total number of numbered pages). The counting of page number, in particular, help us to present data on numbered pages containing academic content. This analysis is presented in section 2.

3.2 Data on Authors & Institutions

Data captured in this section relates to authors and their institutions. We collected data on the number of authors, author names, first/corresponding and co-authors, their respective designations, data on institutional and departmental affiliations and their geographical locations, etc. Some of the fields are now described below:

- Author names – in the data cleaning stage, all names were standardized to only include the first and last name.
- Number of author positions/designations - the number of positions per author, wherein each position has a corresponding country, organization, and department. Information is gathered first from a paper's footnotes and then compared with authors' biography included at the end.
- Name of author position/designation - the author's position as stated in the biography. Some standardization was required to regroup similar roles. For instance, if someone is credited as being the "Boris Johnson Professor of International Relations", we truncated this to only "Distinguished Professor." Positions such as "Head" or "Chief" denote that

this person is in a leadership position in a department/unit/research center and we have coded this accordingly.

- Academic, practitioner or student - this lets us differentiate between *academics*, who teach or conduct research, *practitioners*, who conduct research for the government or a private company, and students, who are studying towards a degree at the time of publication of the paper.
- Author affiliation pertaining to organization/institution and department/research centers - all institutions mentioned in the footnotes or in the biography. This include institutions in which the author was working/studying or had worked/studied previously. The same is true for department/research centers.
- Author country of affiliation- this is the country of the author's affiliated institution (this is not the nationality of the author). Note, one author can work in multiple institutions based in different countries.

3.3 Article-specific Data

Here were collected data specific to a paper and would apply to all authors and their affiliated institutions.

- Funding organization - the organization listed as providing the funds for research. Thus, this does not include the name of the fund or any institution administering the funds.
- Citations – the citation counts given by Google Scholar and Scopus. We mark records as not applicable (N/A) in case of guest editorials and in the rare case that Scopus is missing records on a paper. For the sake of consistency all citations counts were updated on October 10th 2016.

4. FINDINGS

The following analyses will be presented in this section: (a) Analysis based on authorship (section 4.1); (b) Analysis based on authors' geographical location (section 4.2); (c) Analysis based on authors' designation (section 4.3); (d) Analysis based on authors' departmental affiliation (section 4.4); (e) Analysis based on authors' institutional affiliations (section 4.5); (f) Analysis based on authors' publications (section 4.6); (g) Citation analysis (section 4.7); (h) Analysis of sources of funding (section 4.8).

4.1 Analysis based on Authorship

Our analysis pertaining to the number of authors revealed that the total instances of authors that have contributed to the journal during the period 2012-2016 is 535 (this includes 70 authors who have double affiliation). The number of unique authors is 454. Of these, 402 (88.3%) have contributed to one paper and the remaining 53 authors have more than one contribution. Moreover, 149 (32.8%) authors appear as first authors and the remaining 305 are

contributors/co-authors. Among the papers published, 7.4% were single-authored (12 papers), 24.5% were by two authors (40), 35.6% by three authors (58 articles; this forms the largest category), 14.7% by four authors, 10.4% by five authors (Table 3). In general, the average number of authors per paper was 3.28. The total mean was calculated by averaging all 163 papers (not averaging the averages). As shown in Table 4**,** there seems to be a slight increase in the average number of authors in 2013 and 2016. This indicates that authors publishing in JDMS engage in collaborative research which is congruent with the idea of teams working together to solve problems using M&S.

Table 3: Authorship count

Number of Contributing Authors	Count	Percent
1	12	7.4%
2	40	24.5%
3	58	35.6%
4	24	14.7%
5	17	10.4%
6	5	3.1%
7	5	3.1%
10	1	0.6%
13	1	0.6%
Total Papers	**163**	**100.0%**

Table 4: Average number of authors

Year	Mean #Authors	#Papers
2012	3.07	28
2013	3.65	31
2014	3.23	31
2015	3.03	37
2016	3.44	36
Total	**3.28**	**163**

4.2 Analysis based on Authors' Geographic Location

Our analysis of the authors' affiliations revealed that contributors came from 22 different countries, with *US* (65.9%) clearly dominating. The second largest category of authors was formed by authors affiliated to either *Canadian* or *Turkish* institutions respectively (7.5% respectively), followed by *UK* and India (2.6% each). Table 5 shows the top 20 countries in terms of (a) the geographical location of the authors' affiliations (columns 1-3), and (b) the total region-specific contributions of the authors taking into consideration the fact that authors could have contributed to more than one paper (columns 4-6). The total number of unique authors in the top-20 list is 454; total number of contributions is 535.

Table 5: List of the 20 geographical locations based on (a) authors' affiliation (b) and total number of author contributions

Country (a)	Unique Authors (a)	Total % (a)	Country (b)	Author Contributions (b)	Total % (b)
US	299	65.9%	US	369	69.0%
Canada	34	7.5%	Canada	40	7.5%
Turkey	34	7.5%	Turkey	37	6.9%
India	12	2.6%	UK	13	2.4%
UK	12	2.6%	India	12	2.2%
Germany	9	2.0%	Germany	9	1.7%
China	7	1.5%	Sweden	8	1.5%
Finland	7	1.5%	China	7	1.3%
Sweden	7	1.5%	Finland	7	1.3%
Malaysia	6	1.3%	Malaysia	6	1.1%
Australia	5	1.1%	Australia	5	0.9%
Slovenia	5	1.1%	Slovenia	5	0.9%
Thailand	4	0.9%	Thailand	4	0.7%
South Korea	3	0.7%	South Korea	3	0.6%
Iran	2	0.4%	Iran	2	0.4%
Italy	2	0.4%	Italy	2	0.4%
Netherlands	2	0.4%	Netherlands	2	0.4%
Singapore	2	0.4%	Singapore	2	0.4%

France	1	0.2%	France	1	0.2%
Philippines	1	0.2%	Philippines	1	0.2%
Total	**454**	**100.0%**	**Total**	**535**	**100.0%**

It is perhaps not surprising that the largest contribution is from the *US*. This is because the journal was created and established in the US with US editors. However, the large representation of other countries indicates the journal's international audience and reputation. It is also important to note Turkey is the third leading country in terms of contribution and further evidence of the vibrant defense research community in that country.

4.3 Analysis based on Authors' Designation

This analysis considers authors' background under the following three broad categories - *Academic*, *Practitioner* or *Student*. A total of 451 unique authors report their status. Our analysis has shown that the majority of the authors were from the academia - 216 authors; 47.9% compared to 37.7% (170 authors) from the industry. Students account for the remaining 14.4% of unique authors.

Table 6 lists the top 10 author designations, by which we mean title/position of the author at the time the paper was published and as reported by the author. For this analysis, double affiliations were not considered. 396 positions were reported out of 454 unique authors. Our analysis shows that *Professors* and *PhD students* were the top two author designations, contributing to approx. 13% and 11% of publications respectively. This was followed by *Assistant Professor* (9.6%) and *Associate Professor* (5.8%). Practitioners such as *engineers* (aerospace, civil, simulation, etc.) contributed to 3.8% of the paper; if we add *defense scientists* to this category, then it would be the fourth largest in terms of author designation (6.1%).

At first, these findings are surprising considering the journal's stated preference for publishing work rooted in practical experience. However, it is often the case that PhD students in the defense area are also members of the community of practice. Since JDMS is among the relatively few scholarly avenues that publishes defense research, students tend to publish key findings of their work in the journal. Consequently, although self-identified practitioners represent a lower percentage of authors, the total percentage of actual practitioners might be closer to 15 %.

Table 6: List of top 10 author designations

Author Designation	Total	Total %
Professor	52	13.1%
PhD student	44	11.1%

Assistant Professor	38	9.6%
Associate Professor	23	5.8%
MS student	22	5.6%
Research Engineer, Advisory Engineer, Aerospace Engineer, Civil Engineer, Electronics & System Engineer, Simulation Engineer, etc.	15	3.8%
Researcher	14	3.5%
Research Assistant	14	3.5%
Departmental Head	9	2.3%
Defense Scientist	9	2.3%

4.4 Analysis based on Authors' Departmental Affiliations

Table 7 presents the departments/units in which the journal authors are located. From a total of 454 authors and co-authors we could only gather information for approximately 73% (333 authors). For the remaining authors no data were provided in the published papers. We had clustered the names of the authors' departments/units under more general and distinct headings. For example, the first category is *Engineering* - it incorporates all engineering departments, except for those that are clustered under the second most popular category of *Computer Science, Information and Communication* (e.g., electronics, robotics, technology, security engineering) and Aerospace engineering which is mentioned separately in the 6th category. The *Defense* category includes units of Air Force, Special Forces, missile command, homeland security, ballistics and warfare operations, etc. Our analysis of the department/units-specific affiliation information showed that the largest number of contributors were from departments under the umbrella categories of Engineering (32.4%) and Computer Science & ICT (23.7%), accounting together for more than 55% of authors. It is interesting to note that all the departments listed practice M&S in some form. The fact that pure engineering is the leading home for authors is expected because of the emphasis on practical applications.

Table 7: Classification of the authors' departmental affiliation under 8 broad categories

Department/Unit	**Total**	**Percentage**
Engineering (Mechanical, Industrial, Electrical, Energy, etc.)	108	32.40%
Computer Science, Information & Communication Technologies (ICT)and Electronics Engineering	79	23.70%
OR, Modelling & Simulation	55	16.50%

Defense	37	11.10%
Maths, Statistics & Science	17	5.10%
Aerospace & Naval Science	16	4.80%
Business & Management	5	1.50%
Other	32	9.60%

4.5 Analysis based on Authors' Institutional Affiliations

The data for this analysis was readably available as almost all the papers indicated the institutional affiliation of the contributing authors. This data also allowed us to do an analysis of institutions that are not engaged in teaching (we refer to them as "practitioner organizations. 221 institutions were identified (counting all related author affiliations). There are 153 occurrences where at least one of the authors will appear with more than one affiliation. The maximum number of author affiliations reported was four. In Table 7 only first author affiliation was considered for the measures. The breakdown of the number of papers with regard to the contribution of individual institutions is illustrated in Table 8 (columns 1-2). Columns 3-4 show the number of unique contributors/authors affiliated to a particular institution. Finally, columns 5-6 show the total number of contributions from all the authors affiliated to specific institutions. Data for columns 5-6 is obtained from our dataset by counting the occurrence of different educational institutions associated with the authors of a paper. We call this the *total contributions approach*. This measure is different from the number of papers that each institution has contributed to (columns 1-2), since there are papers with more than one author from the same institution. It is also different from the number of contributors/authors affiliated to a particular institution (columns 3-4) because an author may have contributed to more than one paper. The total contributions approach results in the combined count of all authors being greater than the total number of articles.

Table 8: List of the top institutions based on Simple Count: (a) Total Papers – columns 1 and 2, (b) Unique Authors – columns 2 and 4, (c) Total Contribution – columns 5 and 6.

Institution and #Total Papers		**Institution and #Unique Authors**		**Institution and #Total Contribution**	
Air Force Institute of Technology	21	Air Force Institute of Technology	47	Air Force Institute of Technology	62
Old Dominion University	13	Naval Postgraduate School	21	Old Dominion University	36
Naval Postgraduate School	9	Old Dominion University	19	Naval Postgraduate School	27

TÜBİTAK BİLGEM	6	Defense Research and Development Canada	14	Defense Research and Development Canada	14
University of Alabama in Huntsville	5	TÜBİTAK BİLGEM	9	Colorado State University	11
Army Research Laboratory; Defense Research and Development Canada; Pennsylvania State University; University of Central Florida; University of Texas at Arlington	4 each	Army Research Laboratory; Colorado School of Mines; Middle East Technical University; University of Michigan	8 each	TÜBİTAK BİLGEM	10
Colorado School of Mines; Colorado State University; Duke University; Middle East Technical University; Missouri University of Science and Technology; MITRE Corporation; Naval Health Research Center; Royal Military College of Canada; Shijiazhuang Mechanical Engineering College; University of Michigan	3 each	Colorado State University; University of Central Florida; University of Nebraska; US Military Academy	7 each	Army Research Laboratory; Royal Military College of Canada; University of Michigan; University of Texas at Arlington	9 each

From Table 8 we see that *Air Force Institute of Technology* is ranked first with the largest number of papers (21), authors (47) and total contributions (62). *Old Dominion University* and *Naval Postgraduate School* rank second and third respectively with regard to total number of papers and total contribution. In relation to unique authors, *Naval Postgraduate School* appears before *Old Dominion University*. The vast majority of the remaining Universities that feature in the top 10 list are based in the US, notable exceptions being *TÜBİTAK BİLGEM* (Turkey) and *Defense Research and Development* (Canada). The other non-US institutions include *Middle East Technical University* (Turkey) and *Shijiazhuang Mechanical Engineering* (China). Of the three leading institutions, two institutions (NPS and AFIT) have military roots and the

third (ODU) collaborates extensively with the military. From an academic standpoint, ODU and NPS have two of the earliest degree granting programs in M&S in the world. Consequently, it is not surprising to see these institutions leading the list in papers produced.

4.6 Analysis based on Authors' Publications

The focus of our next analysis was to determine the authors who have published the most number of papers during the period 2012-2016. For assessing research published in JDMS, we counted the number of publications from each author/co-author. Table 9 lists the six most published authors, along with their affiliations and geographical locations, sorted by the number of publications as well as alphabetically for authors sharing the same number of publications. In order to present the findings of this analysis, we have included only those authors in the table who have published four or more articles during the period studied. Our analysis has shown that one author has five contributions, five authors have four contributions each, 15 authors contributed with three papers each, 33 are authors in two JDMS papers, 401 authors have only one contribution to the journal.

Table 9: List of the top 6 most published authors with four or more publications, their affiliations and the order of authorship

Author	Institution	Country	Total papers	First author	Co-author
Saikou Diallo	Old Dominion University	US	5	3	2
Frank Lewis	University of Texas at Arlington	US	4	0	4
Jack Brimberg	Royal Military College of Canada	Canada	4	1	3
Jose Padilla	Old Dominion University	US	4	1	3
Michael Grimaila	Air Force Institute of Technology	US	4	1	3
Ross Gore	Old Dominion University	US	4	0	4

Table 9 shows that, in total, the six authors have contributed to 25 scholarly publications, of which they were the first authors for 6 articles. *Saikou Diallo (Old Dominion University)* has the most number of publications (5) and also publications with first authorship (3). Three of the authors are from Old *Dominion University*; Royal Military College of Canada is the only non-US institution in the table.

4.7 Citation Analysis

We conducted a citation analysis to determine the research impact of the papers published in the journal. Citation counts can be extracted from different two databases - *Google Scholar* and

Scopus. Recent studies have compared databases to illustrate that indexing databases possess some shortcomings which may affect the quality and the precision of citation data [13-15]. For example, [15] found that *Google Scholar* records citations from all sources including conferences, book chapters, working papers, and other non-traditional sources which may affects the quality of citation data. We therefore decided to include Scopus as an additional indexing database.

Table 10 presents citation data from both *Google Scholar* and *Scopus*. This data was collected in October 2016. Only articles with seven or more Scholar citations were included in our analysis (a total of 11 papers). Citation counts were then updated for these 11 papers in September 2017. Total citation count presented in table 10 excludes self-citations by any of the co-authors of the original article. The articles are ranked according to the number of *Google Scholar* total citations *minus* self-citation. The table also shows average citations, which is total citations (minus self-citations) divided by the number of years since publication. This is yet another way to measure the impact of articles by taking into account the years passed since publication. This is important since older articles have a higher chance of having more citations, and average citations (or "citations per year") allow comparative citation measures amongst articles.

Table 3: List of the top 11 most-cited papers (excluding self-citations) reported by Google Scholar and Scopus. Papers listed according to the number of citations (excluding self) that is reported by Google Scholar (as in September2017)

Article (only the first author is indicated)	Google Scholar (sorted based on Total Cites)		Scopus	
	Total Citations	Average Citations	Total Citations	Average Citations
Martins G, Moses A, Rutherford MJ, Valavanis KP. (2012). Enabling intelligent unmanned vehicles through XMOS Technology. *JDMS*, **9(1)**: 71-82.	14	2.8	2	0.4
Grimaila MR, Myers J, Mills RF, Peterson G. (2012). Design and analysis of a dynamically configured log-based distributed security event detection methodology. *JDMS*, **9(3)**:219-241.	13	2.6	6	1.2
Whitney SJ, Temby P, Stephens A. (2014). A review of the effectiveness of game-based training for dismounted soldiers. *JDMS*, **11(4)**:319-328.	12	4	9	3

Singaravelu J, Jeyakumar D, Rao BN. (2012). Reliability and safety assessments of the satellite separation process of a typical launch vehicle. *JDMS* , **9(4)**: 369-382.	11	2.2	9	1.8
Thumati BT, Dierks T, Sarangapani J. (2012). A model-based fault tolerant control design for nonholonomic mobile robots in formation. *JDMS*, **9(1)**:17-31.	11	2.2	6	1.2
Roza M, Voogd J, Sebalj D. (2013). The Generic Methodology for Verification and Validation to support acceptance of models, simulations and data. *JDMS*, **10(4)**: 347-365.	11	2.75	4	1
Hodson DD, Hill RR. (2014). The art and science of live, virtual, and constructive simulation for test and analysis. *JDMS*, **11(2)**: 77-89.	10	3.33	6	2
Griffin B, Fierro R, Palunko I. An autonomous communications relay in GPS-denied environments via antenna diversity. (2012). *JDMS*, **9(1)**: 33-44.	10	2	n/a	n/a
Blount EM, Ringleb SI, Tolk A, Bailey M, Onate JA. (2013). Incorporation of physical fitness in a tactical infantry simulation. *JDMS*, **10(3)**: 235-246.	9	2.25	3	0.75
Tolk A, Bair LJ, Diallo SY. (2013). Supporting Network Enabled Capability by extending the Levels of Conceptual Interoperability Model to an interoperability maturity model. *JDMS*, **10(2)**: 145-160.	8	2	6	1.5
Evangelista PF, Darken CJ, Jungkunz P. (2013). Modeling and integration of situational awareness and soldier target search. *JDMS*, **10(1)**: 3-21.	4	1	0	0

As can be seen from the table, Google Scholar reports a higher number of citations for each paper. This is to be expected since Scholar includes citations from not only traditional academic sources but also from university repositories, author websites and websites maintained by

journal publishers [16]. The article by *Goncalo Martins et al.* (2012) has the highest number of total citation in Google Scholar (15 citations). It describes the design for intelligent unmanned vehicles using a new event-driven parallel processor for embedded systems. *Andreas Tolk et al.* (2013) are the authors of the paper with the highest number of citations reported by Scopus (six citations). The paper is on North Atlantic Treaty Organization (NATO) Network Enabled Capability (NNEC) and supporting it through the levels of Conceptual Interoperability Model and extended to an Interoperability Maturity Model. The paper also has the second highest number of citations from Google Scholar (14 citations). The paper by *Susannah Whitney et al.* (2014) is a critical review of existing studies that have examined game-based training with dismounted soldiers. Although the paper was published in 2014, it already has 13 citations. There are two papers with the second highest number of citations that are reported by Scopus (five citations each) – the paper by *Michael Grimaila et al.* (2012) is on cyber security in which they critique centralized event logging and demonstrate the utility of a log-based distributed security event detection methodology; the second paper is by scientists (*Singaravelu et al., 2012*) associated with the Indian space program in which they present the formulation of the rigid body separation dynamics that is useful for the design of satellite separation process of a typical launch vehicle.

Of the 11 papers reported in our citation analysis, five papers were published in 2012, four papers in 2013 and two in 2014 respectively. In terms of average citations (this takes into account the publication year) the review paper by *Susannah Whitney et al.* (2014) comes first with an average of 4.3 cites (Google Scholar). The paper by *Andreas Tolk et al.* (2013) comes next (average of 3.5 citations) and also scores high in average cites reported by Scopus.

4.8 Analysis based on Funding Body

Authors acknowledge the source of funding. We collected this information and counted the frequencies; sometimes this involved merging of data, for e.g., the acronym *NSF* was merged with *National Science Foundation*. 72 studies out of a total of 163 received funding (approx. 45%) – this shows the relevance of the journal in terms of informing practice. Also, 22 studies received funding from multiple sources (different authors may have had different funding). Table 11 presents the list of the top-11 institutions that have funded three or more studies. The *National Science Foundation* comes at the top with nine studies, followed by *Air Force Research Laboratory*, *Army Research Laboratory, Office of Naval Research* and *Department of Energy* (funding five studies each). As is to be expected in a journal specific to defense, with the exception of *National Science Foundation* and the *Natural Sciences and Engineering Research Council of Canada*, the other funders are either military organisations or administrative departments related to defense and national security, e.g., the *Department of Energy, Department of Defense, Office of the Secretary of Defense.*

Table 4: List of top 11 organizations providing funding for research published in JDMS

Funding Organization	**Count**
National Science Foundation (US)	9
Air Force Research Laboratory (US)	5
Army Research Laboratory (US)	5
Office of Naval Research (US)	5
Department of Energy (US)	5
Air Force Office of Scientific Research (US)	4
Laboratory for Telecommunications Sciences (US)	4
Natural Sciences and Engineering Research Council of Canada (Canada)	4
Office of the Secretary of Defense (US)	4
Department of Defense (US)	3
Naval Postgraduate School (US)	3

As can be seen from the table above, ten of the eleven organisations funding research are based in the US (the exception being Canada). Other countries that are not included in the table include, UK (*Engineering and Physical Sciences Research Council, BAE Systems, Defense Science and Technology Laboratory*), Sweden (*Vinnova Swedish Governmental Agency for Innovation Systems; Swedish Armed Forces*), India (*Department of Science & Technology*), Germany (*German Federal Armed Forces*), Malaysia (*Institut Kejuruteraan Tentera Darat; Malaysia-Japan International Institute of Technology; Malaysian Ministry of Education*), Korea (*Korean Ministry of Knowledge Economy; Korean Ministry of Trade, Industry and Energy*), Italy (*Ministry of Defense*), Turkey (*Scientific and Technological Research Council of Turkey; Technology Development Foundation of Turkey; Turkish Ministry of Defense R&D Office*) and Slovenia (*Slovenian Ministry of Defense*). Private organisations that have funded research include *Lockheed Martin Corporation*, *Raytheon Company* and *Exostrategies Inc*. (one study each). *Defense Advanced Research Projects Agency (DARPA)* has funded one project. The specialised nature of the journal is evident from US funders that are working in specialised areas, for example, funding has been made available by *Air Combat Unit, Air Force Global Logistics Support Centre, Naval Meteorology and Oceanography Command, Naval Oceanographic Office, Office of the Secretary of Defense Cost Assessment and Program Evaluation, US Army Armament Research, Development and Engineering Cente*r, etc. It is widely assumed that most of defense M&S work is supported by the Department of Defense

(Ministry of Defense) in respective countries. Table 11 showing NSF as a top funder probably reflects funding for researchers affiliated with universities. However, a closer look reveals that defense funding represents the overwhelming majority of funding sources.

5. CONCLUSION AND RECOMMENDATIONS

The objective of this profiling paper was to present the readers with an overall picture of research published in JDMS and to highlight the contribution of the authors and institutions that are engaged in the domain-specific field of defense M&S. Our dataset for this review included a total of 163 articles; 103 regular and 60 special issue papers. For every paper, the authors captured data on variables pertaining to the year of publication, the number of contributing authors, the author names and their affiliations (both university and department, together with their geographical location), the background of the authors (e.g., academic or practitioner), the designation of the authors, whether the paper appeared as part of a regular issue or a special issue, information on funding bodies, and the metrics on paper citations from Google Scholar and Scopus. Extracting detailed information of the aforementioned variables not only required reviewing the author information, the abstract and the keywords of every paper, but in some cases it was necessary to read the full text. Collation of data pertaining to these variables enabled the analysis of additional parameters such as the productivity of authors, institutional contributions, citations of selected articles and geographic regions.

We learned from a founding member of the journal that one of the motivations for establishing JDMS was to raise the quality of publication for the practicing engineers and scientists within the defense community. The predominant publications at the time of JDMS founding were conferences and workshops like *SIW (SISO Simulation Innovation Workshop)* and *I/ITSEC (Interservice/ Industry Training, Simulation and Education Conference),* and generally the perception was that the overall quality of the papers in these proceedings could be improved. The military Operations Research community had high quality outlets for their work in the *Military Operations Research Society (MORS)* journals, but for the Computer Science and Computational Social Science focused work in M&S (interoperability, synthetic natural environments, human behavior representation, etc.) there was not a good venue. Publication outlets like *Simulation: Transactions of the SCS* and *ACM TOMACS* were mostly academic focused, and the founders realized there was an opportunity to start a new journal that could be more relevant to the practicing engineers and scientists. The data presented in this paper shows that the original purpose of the journal and its intent may have evolved in the intervening years and the authorship, at least for the period analysed in this profiling study, is predominantly academic. Since academics are incentivized to publish in journals, this is not surprising. The proportion of papers originating from the military (with .mil and .gov email addresses), defence

contractors like Raytheon, Lockheed Martin, etc. however remains low. We believe that this has demonstrated that while JDMS originally set out to be a forum for the defense industry to share ideas and solutions, it has become more than that. It is the forum for the engineering defense community, whether from the industry or the academia. However, an alternative analysis could be that the more practice-focused submissions from these military organizations are being pushed out by the academic papers. Or perhaps the military organizations are not engaged with JDMS? These are important questions and requires further analysis.

Result from this profiling study will be useful for the readers of the journal, the EIC and the members of the Editorial Advisory Board (EAC). This utility derives not only from general observations on the resulting statistics, but also from questions that arise and which may need to be considered as the journal continues to evolve. Questions such as, how does JDMS attain an *Impact Factor*? How can the balance between the academic and the more practice-focused papers arising from military be achieved? How can the contributions from institutions and authors from outside the US be increased (as it should be for an international journal)? How does JDMS achieve a higher *SCImago Journal Rank (SJR)*? How does the journal progress form currently being indexed in *Emerging Sources Citation Index (ESCI)* to being included in the traditional indexes maintained by *ISI Web of Science Core Collection*?

In terms of recommendations, we see three major axes for the Editorial Advisory Board (EAB):

- True Multidisciplinarity: The study has shown most of the authors have an engineering background. The journal needs to make a case for social scientists and humanists who study, model and simulate individuals, cultures and societies to contribute their insights and findings. The work of these scientists is currently being published in general science and specialized journals but has yet to be included and featured in JDMS.
- Reflect the Multidisciplinary approach in the EAB: To appeal to more than engineers, it is important to have a diverse group of Associate Editors who represent fields that are not traditionally represented. This is essential to show that the journal is open to more than one worldview and is truly committed to the advancement of defense and *security*. We add the notion of security to incorporate not just Department of Defense engineering-related work but any work that is allied with security (Cyber, Command and Control, etc.).
- Ensure that as the journal evolves its founding principles are not forgotten: As the journal becomes more receptive to interdisciplinary M&S work being carried out in other disciplines that have a bearing with security and defense (e.g., refugee crisis, immigration, both man-made and environmental disasters, humanitarian logistics, infrastructure, military supply chain, diplomacy, rational choices and decision making),

it is important for the journal to maintain a balance between academic work being done in the universities and the more practice-focused research in military.

We analyzed 753 unique author keywords from 163 papers (852 instances in total) and the frequency count identified the most frequently used author keyword to be the following - *Simulation, M&S, Decision Making, Discrete-Event Simulation, Modelling, Optimization* and *Validation.* This shows that the core of the journal remains to be in M&S and associated approaches. With the objective of attracting more papers, the traditional M&S remit of the journal could be extended to also include articles using analytical techniques from the field of Operational Research/Management Science (e.g., mathematical programing, optimization approaches, multiple-criteria decision-making, soft Operational Research) and its application to defense and security.

Table 5: Journal peer-review activity from 2012-2016

Year	Submission	Accepted	Rejected	Reject and Resubmit	Average days to decision
2012	45	27	10	4	121
2013	39	4	6	8	168
2014	44	3	3	4	134
2015	55	1	4	15	121
2016	74	8	5	14	98

The number of papers submitted to the journal demonstrates an increasing trend. The exception is year 2013; 39 papers were submitted (either original or revised manuscripts) compared to 45 in 2012. From the paper acceptance data shown in Table 12 above, it could be argued that, starting from 2013, JDMS has tried to ensure better quality of publications through its peer-review process. This is demonstrated by the following three measures: (a) the number of papers accepted (this includes *'accept as is'*, *'minor revision'* and *'major revision'*) has reduced sharply from 27 papers in 2012 to single digit acceptance figures from 2013 onwards; (b) papers with the decision *'reject and resubmit'* has increased from 4 in 2012 to 14 in 2016, and this has, in turn, contributed to the increasing number of submissions that was discussed earlier; and (c) there is a marked change in the metric associated with the *'average days to decision'*, which has fallen from 168 days in 2013 to 134, 121 and 96 days in 2014, 2015 and 2016 respectively. Although the data presents an interesting analysis of JDMS in terms of its peer-review activity, it is to be noted that the review cycle is a continuous process, and the timespan associated with submission of manuscripts, return of peer reviews, first decisions, etc. can extend to multiple years. This being said, there is a strong evidence of an intrinsic quality pattern emerging from 2013 onwards. It is to be seen whether this would translate to higher journal ranking for JDMS in the years to come.

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