EXPLORING QUANTITATIVE SKILLS PROVISION IN EUROPEAN LOGISTICS AND SUPPLY CHAIN EDUCATION

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Introduction

Logistics comprises functional 'stop' and 'go' activities such as warehousing, inventory management and transport, and logistics strategy has focussed on making these activities more efficient, effective and relevant (Grant, 2012). Techniques for doing so require quantitative skills for logistical system design and analysis and hence logisticians should possess a degree of quantitative skills to undertake these tasks. The broader concept of supply chain management (SCM) includes developing and managing relationships with stakeholders, internally and externally, along the supply chain– such stakeholders include shareholders, employees, customers, suppliers and possibly even competitors in collaborative opportunities. Accordingly, both logisticians and supply chain managers should also embrace 'softer' management and less quantitative skills in order to achieve these functions. However, this is not to say that both types of skills are not required at all levels.

Arguments surrounding the interaction of logistics and SCM (Larson and Halldórsson, 2004) have led to confusion and debate over what curriculum universities should provide to undergraduate (UG) and postgraduate (PG), i.e. Masters of Science (MSc) or Business Administration (MBA) students in logistics and/or SCM programmes. Wu (2007) examined academic curricula featured on university websites across the globe and found inter alia that most courses or programmes tend to be function-oriented. Wu suggested that "a truly integrated and effective logistics program can help students to keep pace with the business world and be equipped with the skills industry desires" (2007: 524).

One school of thought considers that students taking logistics, SCM and operations management (OM) programmes require more 'softer' or interpersonal skills to meet needs of industry and employers (Gammelgaard and Larson, 2001; Bennis and O'Toole, 2005; Gabric and McFadden, 2001). However, another school argues that students lack sufficient quantitative skills to meet industry and employers' needs (Powell, 1997; Sodhi et al., 2008). This view is receiving more weight nowadays as firms are focussing on 'big data' and data analytics, especially in supply chains (Hazen et al., 2014).

Following on from this debate is a view that students in certain programmes, such as general business, shy away from taking quantitative courses or modules due to either a lack skills or confidence in numeracy (Murtonen and Lehtinen, 2003; Pokorny and Pokorny, 2005). If that is the case and if the latter school of thought above has more merit than the former, meaning students may lack sufficient quantitative skills, how then should colleges and universities shape their programmes and curriculum going forward for the rest of this decade?

This paper's reports on an ongoing research project investigating these points of view through a discussion of extant literature and an exploratory study to determine which school of thought regarding quantitative skills has currency with European academics, and if the 'needs more quantitative skills' thought is prevalent, determine how these academics are addressing that issue.

LITERATURE REVIEW

In a logistics education special issue Poist et al. (2001) surveyed US and European logistics managers regarding their skill preferences for logistics managers operating in the new European Union environment. They found experience in international business, a foreign language (i.e. other than English), and general communication and

interpersonal skills were important to respondents. In contrast, technological literacy and quantitative skills were only considered neutral by over half of their 279 survey respondents. Poist et al. concluded that their findings should drive curriculum development towards seminars, short courses and management development programmes aimed at the important interpersonal skills identified. Supporting this view in the same issue was work by van Hoek (2001) advocating in-company projects and case studies, Alvarstein and Johannesen (2001) discussing problem-based learning approaches, and Grant (2001) demonstrating the value of short, sharp 'block courses' to deliver logistics and SCM content. Additionally, Gammelgaard and Larson (2001) examined skill sets required by logistics managers to perform SCM as provided by members of the Council of Supply Chain Management Professionals (CSCMP). Their analysis of thirty-nine skill area variables generated three distinct latent constructs: interpersonal/managerial skills such as inter alia critical reasoning, organising, problem solving, time management and communication; quantitative/technological skills comprising information technology (IT), quantitative, statistical and spreadsheet; and SCM core skills such as change and conflict management, leadership and teamwork.

Bennis and O'Toole further suggested that business schools had lost their way by emphasising scientific research rigour and adopting the scientific model that uses "abstract financial and economic analysis, statistical multiple regressions, and laboratory psychology" with little research "grounded in actual business practices" (2005: 96). They considered business akin to a profession such as law and advocated a broader focus on humanities subjects such as: economics, psychology, accounting, politics, philosophy, history, sociology, language, and literature. Finally, Gabric and McFadden (2001) examined employer and student perceptions of desirable entry-level skills for operations management (OM) and found what businesses required were markedly different than what students thought they wanted. They concluded that technical skills are important, but do not outweigh general skills, and that OM courses "should develop students' quantitative abilities with the integration of general management skills, such as problem-solving, team building and listening" (2001: 58). Thus, recommendations stemming from all these articles were for HEIs to provide more holistic general management courses emphasising the 'softer' skills of management that are needed in twenty-first century SCM and OM situations.

However, another stream of articles has noted a shortcoming in reducing the amount of quantitative courses and possible resultant skills of university students. Murtonen and Lehtinen (2003) described difficulties experienced in learning quantitative methods by students and found that statistics and quantitative methods courses were experienced by students as being more difficult than other domains, such as qualitative methods and the students' main subjects. They considered students tended to polarise academic subjects into 'easier' language, major and qualitative subjects, and 'harder' mathematical, statistical and quantitative subjects and established five main categories of reasons for difficulties: superficial teaching, linking theory with practice, unfamiliarity with and difficulty of concepts and content, creating an integrated picture of research in order to really understand it, and negative attitudes toward these studies. They found that students who gave high ratings for the difficulty of statistical and quantitative subjects cited teaching most frequently as the reason. Pokorny and Pokorny (2005) noted that the UK government's widening participation strategy and the concomitant development of a mass higher education system has imposed a variety of pressures on HEIs, including assumptions about the resultant skills and knowledge base they provided. The Pokornys identified the lack of numerical literary as one of a range of factors that could explain the variability of student performance on first-year UG statistics courses and challenged the presumption that students can rapidly become independent learners upon initial entry to higher education as an unrealistic one. Lastly, Sodhi et al. (2008) analysed 704 MBA-level SCM job advertisements to determine the proportion of skills required by employers and the curriculum of twenty-one business schools in the top fifty MBA programmes in the US to determine if they provided those skills. They found that the curriculums

offered a relative over-supply of conceptual and strategy-oriented i.e. qualitative topics and a relative under-supply of practice- and process-oriented i.e. quantitative topics compared to advertised employment demands.

Thus, there is a limited but important and healthy debate regarding the importance of quantitative skills and their requirement by employers. However, given the origin of quantitative functions in the logistics domain and its continued importance in achieving efficiency gains (Grant, 2012), what level of quantitative skills should UG and PG students possess relative to broader management skills, and how should they acquire them in college and university courses and programmes?

Kretovics (1999) used learning skills profile (LSP) sets and measured quantitative skills within set of analytical skills that also included theory and technology skills. He defined quantitative skills as "the ability to use quantitative tools to analyze and solve problems and to derive meaning from quantitative reports" (1999: 129). Thus, we argue that an inventory of skills needs to satisfy these three criteria: the ability to analyse, the ability to problem-solve and the ability to interpret data to derive meaning. From a holistic perspective, skills need to be integrated and case studies are considered best-placed to do so (Johnson and Pyke, 2000), need to be seen in a globalised setting as SCM is a global activity (Kopczak and Fransoo, 2000), and should be reinforced from outside the academy through guest lectures and site visits (Grant, 2001; van Hoek et al., 2011). Lastly, there are also well-established mathematical techniques and models to improve quantitative learning such as the economic order quantity (EOQ) for inventory management (Harris, 1913), the square root law for rationalising warehouses (Maister, 1976), the Forrestor effect affecting demand (Forrester, 1958), various types of simulations (Fry, 2008), games such as the popular 'beer game' and various derivatives (Knolmayer et al., 2007), and the increasing use of web-enabled tools such as Wikis (Neumann and Hood, 2009).

From this debate about the importance of quantitative or 'hard' skills for logistics and SCM students relative to other general or 'soft' skills, and an uncertainty regarding the balance between them for employer requirements in the workplace, our research projects seeks to investigate in a European context (a) the current state of students' quantitative skills as perceived by academics, (b) what academics are doing about any insufficiency in such skills, and (c) whether any interventions through their curriculums make a difference.

METHODOLOGY

Our methodology is exploratory as we are trying to understand opinions and behaviour by academics in European higher education institutions. Hence, an inductive approach is appropriate for this project and our approach consisted of a Delphi method using a structured series of questions to conduct this exploratory investigation. Our empirical research aim was to obtain a reliable consensus of a group of educational experts in logistics and supply chain management education in Europe. Given the possible dichotomy regarding quantitative skills of students and various approaches in addressing them, a Delphi study was considered appropriate to generate initial qualitative data for analysis and verification in further rounds.

The Delphi method was developed at the RAND Corporation as a means of collecting and synthesizing independent expert judgments (Helmer and Rescher, 1959) and since then the technique has often been used across a broad spectrum of topics in the social and natural sciences. Participants are chosen for their expertise in some aspect of the problem under study and are promised anonymity with respect to their answers. The value of the Delphi method rests with the ideas it generates in studies that evoke consensus and those that do not. The arguments for any extreme positions also represent a useful output.

Based on our research objectives outlined in the literature review, we developed five open-ended questions as shown in Table 1. We have only undertaken a single Delphi round to date.

Q1. Do you perceive that your logistics and SCM students lack sufficient quantitative skills? Why or why not, i.e. how do you know?
Q2. Does your programme provide any additional learning or training in quantitative skills to address any shortcomings? If so, please describe the nature of such additional learning or training.
Q3. Do you incorporate any quantitative-based techniques within modules or courses in your programme to assist students in reinforcing their skills? If so, please describe the nature of such techniques.
Q4. Are you and/or your colleagues able to perceive a difference in students' quantitative skills as a result of either additional learning or training or quantitative-based techniques within modules or course? Why or why not, i.e. how do you know?
Q5. Do you have any other comments or observations on this issue?

Table 1: Open-ended questions for first round of Delphi study

Logistics and SCM academics in thirty-one European universities were invited by e-mail to participate in this Delphi study: eighteen in the UK (58%), six in France (20%), three in Finland (10%), and two each in Denmark and Sweden (6% each). The academics are well-known to the authors and represent in our view leading research and teaching experts in the logistics and SCM domains. Further, the universities selected are also well-known for their undergraduate and/or taught postgraduate (i.e. MSc and/or MBA) logistics and SCM provision. Due to anonymity reasons promised to invitees we are unable to identify the academics and universities selected. Content analysis was used to interrogate the Delphi responses and is presented using usual techniques for qualitative research (Yin, 2003).

FINDINGS

We received eleven completed responses (35% response rate) to our invitation: seven from the UK (UK1 to UK7), three from France (FR1 to FR3), and one from Sweden (SE1).

What is the current state of quantitative skills?

Seven respondents (UK1-2, 4, 6-7; FR1-2) reported students lacked sufficient quantitative skills at either or both UG and PG levels. One reason expressed is the diversity of the student's educational background and/or previous degree, for example:

> "Students …are from diverse backgrounds in terms of their degree discipline. The ones majoring in Geography definitely tend to be short on the quant [sic] side. The ones from the business school tend to be better equipped and the ones from Maths are obviously ahead of the game." UK1
>
> "Yes, it is a reality. I think that quantitative skills are well known in Engineering degrees, not in Management degrees. A sort of 'division of labour' in France." FR1

Another reason is the lack of courses on quantitative skills at lower degrees and the nature of some PG programmes being conversion programmes for newly-graduated UG students, for example:

> "The MSc courses are conversion courses and hence not all students will have a quantitative background. Undergraduates will study logistics and SCM through modules on 'Operations Management' however they too are uncomfortable with quantitative inputs." UK6
>
> "Students lack a formal mathematical background in earlier years (from 1st to 4th year)." FR2

Finally, students are perceived not to have an interest or adequate skills such that they struggle with concepts needed to undertake logistics and SCM analyses, for example:

> "Most [students] do not have adequate knowledge in statistics and maths …some of them do not understand linear programming and simple calculations." UK2
>
> "At undergraduate level ...students often don't choose the logistics/SCM/OM modules because they perceive them to be quantitative (even if they aren't!). ...there are always some who ask as to how quantitative the module would be and how good they would need to be at maths. This observation is also borne out by (i) generally poor performance in accounting modules; and (ii) extremely low take up of quants modules." UK7
>
> "Yes, the students in my Master's program lack math skills to understand the core mathematical formulas. I know because I tried to have them calculate the EOQ by demonstrating the formula and doing some exercises with basic parameters." FR2

Such lack of quantitative skills may prevent students from undertaking placements and might ultimately limit their employability prospect.

> "We have supply chain projects and internships that some students are excluded from because of the quantitative nature of the work." UK4

In contrast, the other four respondents (UK3, UK5, FR3, SE1) cited individual needs assessments where "sufficiency is defined in relation to need which is individually defined," (UK3) and differences in degree classification and student selection as the main reasons their students possessed such skills, for example:

> "Our students are at master levels and they are engineers, e.g. mechanical engineering and industrial management engineering (not MBA), and have a good base in mathematics and optimisation models, etc. They have good mathematical skills, even if our courses are more qualitative. We have a lot of cooperation with industry both in our courses and when they are doing their master's thesis (which is done in a company). From this, we know that our students are very appreciated in industry. They are also getting very qualified jobs direct after their exam." SE1
>
> "Our selection process takes into account the students quantitative skills (tests and serious checking of previous studies) and students without sufficient quantitative skills are eliminated at this stage. There is also a natural selection, in the sense that possible applicants know that quantitative skills are required when they apply to such a master's program." FR3

What are academics doing about the insufficiency of quantitative skills?
The provision of additional training or courses in quantitative skills ranged from none (FR1, FR2, SE1, UK1) through specific seminars and labs on basic statistics and using spreadsheets and SPSS to harmonise skills and eliminate any shortcomings (FR3, UK3, UK5, UK7) to specialist and in-depth courses on quantitative skills (UK2, UK6) and research methods (UK2) and electives on modelling and simulation (UK4). Three respondents (FR1, UK4, UK5) do not offer additional techniques other than specific elective courses in quantitative techniques (UK4). Additional courses offered by the other seven respondents range from small group tutorials (UK2, UK6, UK7), basic inventory and EOQ analysis (FR2, UK1), basic spreadsheet analysis (SE1, UK3), basic statistics or simulation e.g. SIMUL8 or Microsoft Solver (FR3, UK3, UK6), and vehicle routeing and scheduling (UK1).

Is there an improvement in quantitative skills?
Only two respondents perceived no improvement in skills for two different reasons:

"With a very weak background and limited additional help it is hard for students to achieve significant improvement. Average student performance is usually lower when there are more quantitative [elements] in the assessment." (UK2)
"The students tend to self-select and the better ones take the quantitative questions [on exams] and the weaker ones avoid them." (UK1)

Four respondents perceived there was improvement in skills that was seen in the master's thesis (UK5), regular assessment to test this improvement at UG level (FR3, UK4, UK6), students from different educational backgrounds that can "…understand without any problem the cross docking managerial stakes and they are able to organize a cross docking platform! But these students are engineers with a hard background in quantitative skills." (FR1) While SE1 did not consider this an issue, the remaining four respondents either did not know (FR2, FR3) or found it is difficult to tell since "students have numerous different backgrounds (e.g. Engineering to Law) and interests. Quants [sic] is one of perhaps 10 skills on logistics courses – very difficult to pin down particular outcomes to particular causes" (UK3) or "students either 'get it' or not in relation to quants [sic]. The majority tend to not to jump between categories, and the ones that do are the ones who work hard, spend time outside lectures studying the topic and seek help as appropriate" (UK7). Two respondents commented on the implications of this issue. UK1 "would be interested to know – engage in a debate about – what quant [sic] skills we think might be the appropriate ones – or the minimum requirement" while FR1 considered that cultural dimensions, "for instance between the French system and the Anglo-Saxon system, should be investigated," which is a very Northern Europe perspective. On the other hand, UK6 posited a broader cultural approach when he opined that "that quantitative inputs to the courses- 'Operations Management' and 'Logistics and SCM' within the UK are limited. This may be because students are not receptive to quantitative methods. The courses in USA, India and China for example are more quantitative (more towards OR) and this is also evident when comparing text books from the UK and US." This was echoed by UK7 who noted that at PG level "there is a cultural aspect to this. Chinese/Asian students seem to do well in quants [sic] and have the skills to cope."

UK6's reference to different disciplines was also raised by FR2. He considered that there are two different schools of thought in management studies. Those that favour soft sociological skills and those that favour hard analytical, process oriented organizational ones. To my mind, SCM and OM are both OR based and should be taught using quantitative methods and positivist normative scientific tools." The 'soft' side of management education was also noted by SE1 who considered this "might be a problem on MBA programmes, but not on the engineering master programs." However, there is "a risk that a more quantitative programme or a programme that requires quantitative skills as a pre-requisite would be less attractive hence our approach to using the elective modules as the quantitative route" (UK4). UK2 observed that there may be a tendency to make "the quantitative part or the courses 'easier' or reduce the quantitative part." As a result "…graduates are becoming less capable of making decisions based on quantitative method, most tutors choose to teach quantitative methods which are easier to grasp but such methods would not be applicable in the dynamic and complex real-life."

CONCLUSIONS

Almost two-thirds of respondents considered their students lacked sufficient quantitative skills, supporting concerns that the educational landscape has changed over the last decade (Murtonen and Lehtinen, 2003; Pokorny and Pokorny, 2005; Sodhi et al., 2008). Accordingly, students may not be getting the skills that they need in some logistics and SCM programmes to enable them to meet the requirements of the workplace and which may be frustrating employers about their abilities as well as the academy's ability to ensure employability. However, this is not a simplistic assertion as there are possible background factors affecting students' abilities to acquire quantitative skills such as lack

of interest or a perception of difficulty, and previous education and cultural factors such as country of origin and language abilities that may inhibit or enhance those abilities.

Given this concern raised by respondents there were surprisingly few suggestions offered to address it; four respondents do not offer any additional training, three do not offer additional techniques within courses, and four only offer basic skills courses. Unsurprisingly, two respondents considered there was no improvement in quantitative skills and four did not know if there was a difference. Part of the reason for the latter was lack of information on individual students' backgrounds to determine if that made a difference to improvement or not. Additional observations reinforced the generalist school of thought wherein the curriculum was being changed to reflect qualitative or 'softer' skills and as a result it was implied that primarily teaching and assessing students on these skills and downplaying the quantitative aspect is perhaps a self-fulfilling prophecy. The notion of cultural differences of students was raised here also.

As a result, we have two preliminary suggestions for colleges and institutions. First, it should validate employers' needs regarding a proportion of qualitative and quantitative skills in light of Sodhi et al.'s (2008) desk-based study to ensure its curriculums are relevant, particularly in an increasingly data analytics-driven business environment. Second, and based on the results of that exercise, the academy will need to revisit its logistics and SCM curriculum to ensure relevancy not only for employers but also for students. Students and young people in the twenty-first century are 'switched on' regarding technology and 'social media' and the teaching of quantitative techniques need to reflect and embrace these initiatives – quantitative techniques cannot be a 'turn-off' for students and innovative teaching should include the use of technology such as cases, simulations, games and even Internet platforms to solve problems (Johnson and Pyke 2000; Fry, 2008; Neumann and Hood, 2009).

As with all research, there are two limitations to our study. Only eleven experts and well-known logistics and SCM academics across Europe participated in our study out of 31 invitees. While a large percentage response rate the absolute numbers are low and thus our findings may not totally reflect the current state across the entire sector. But, we are satisfied that our findings are indicative of the situation today. Also, we have so far only conducted a single-round Delphi study. Thus, we still need to validate them further to ensure a truly emerging consensus. There was a partial consensus in our findings however four respondents offered different views. As this phenomenon is still under-researched, we consider that our future efforts should continue to explore these issues and we consider finding another and much larger sample to replicate the first round.

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