Is Management Science doing Enough to Improve Healthcare?

Lalit Garg, Sally McClean, and Maria Barton

***Abstract*—**Healthcare issues continue to pose huge problems and incur massive costs. As a result there are many challenging problems still unresolved. In this paper, we will carry out an extensive scientific survey of different areas of management and planning in an attempt to identify where there has already been a substantial contribution from management science methods to healthcare problems and where there is a clear potential for more work to be done. The focus will be on the read-across to the healthcare domain from such approaches applied generally to management and planning and how the methods can be used to improvement patient care. We conclude that, since the healthcare domain significantly differs from traditional areas of management and planning, in some cases there is a need to modify the approaches so as to incorporate the complexities of healthcare, and fully exploit the potential for improvement.

***Keywords*—**Management science, management and planning, transforming services, healthcare.

I. Introduction

OVER recent years there has been increasing activity with regard to using methods from management science in healthcare domains. Within the NHS, such ideas have been championed by such bodies as the NHS Institute for Innovation and Improvement. However, healthcare issues continue to pose huge problems and incur massive costs. In this paper, we describe an extensive scientific survey of different areas of management and planning in an attempt to identify where there has already been a substantial contribution from management science to healthcare problems and where there is a clear potential for more work to be done. The focus will be on the read-across to the healthcare domain from approaches which have been applied generally to management and planning and how the methods can be used to improvement healthcare processes and patient care.

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II. The Approach

Our approach is based on an extensive survey of management and planning methods that have been used in other areas and also to improve healthcare. To carry out this survey, first a classification scheme was developed to categorise the popular management and planning methods. We classify management and planning methods into the following categories: (i) manpower planning methods, (ii) material management and demand forecasting, (iii) inventory planning and supply chain management, and (iv) planning, process improvement and quality control.

We have employed Scopus and Google Scholar (mainly for academic papers); also Google web, Scopus web and Scopus patent database (mainly for the grey literature). We then obtained the number of research articles available in all areas and in healthcare areas, using these databases. This provides us with an idea of the academic interest in each of the methods in healthcare and non-healthcare areas respectively. Similarly the grey literature was explored using Google web search, Scopus web and Scopus patent database. This gives an idea about the popularity of each method among the non-academic community (mainly industry, government and the user community).

We then analysed each method for its application to management and policy design. Relevant graphs presenting comparison of the popularity of various methods are also provided. Finally, popular articles (in terms of citation) were selected, using stratified random sampling) to exemplify each method and to provide a source of further information. In order to obtain the full spread of articles published using each method we have included all alternative keywords. In each case we cite a few of the most popular papers so as to provide the reader with key references.

III. Human Resource Planning (HRM)

From Table I and Fig. 1, we conclude that in the academic literature there is proportionately less published work on more complex methods (stochastic models, mathematical programming and artificial intelligence) than simpler approaches (simple statistical methods and simulation). However, this does not hold for the industrial/practitioner literature where a large proportion of the publications are from healthcare across all methods (see Fig. 2). In addition the most popular methods in both academic and non-academic outlets are simple. Also most patents have been obtained for stochastic methods.

TABLE I
HUMAN RESOURCE PLANNING MODELS

Method type	Industry	Google Web	Google scholar	Scopus	Scopus web	Scopus patents
Simple statistical methods	All	893200	32940	488	57254	449
	H/C	675200	21613	348	45992	183
Simulation	All	1600000	23900	413	115899	684
	H/C	1151000	14930	186	92808	282
Stochastic models	All	600149	10797	221	61482	940
	H/C	467814	7196	56	51393	285
Mathematical Programming	All	126000	4020	165	20980	81
	H/C	96100	2390	43	17821	14
Artificial intelligence based	All	1367400	30569	161	92440	975
	H/C	832717	13308	55	77765	525
All: All industries, H/C: Healthcare industry only						

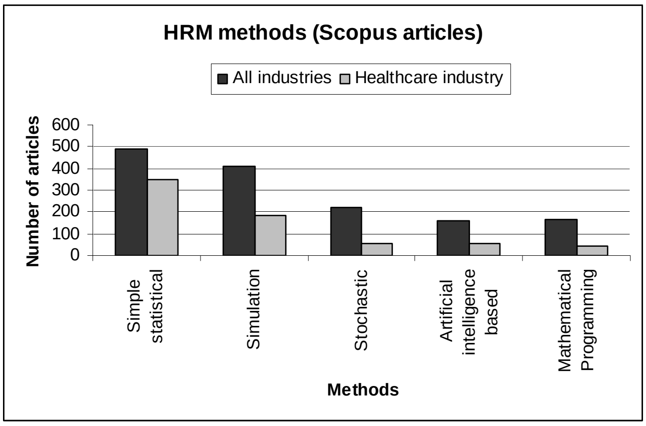

Fig. 1 Comparison of various HRM models in the academic literature (Scopus)

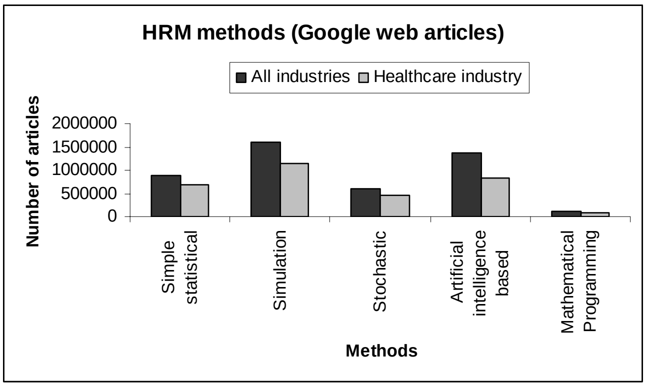

Fig. 2 Comparison of various HRM models in the grey literature (Google web)

Using regression analysis [1] the effect of nurse staffing policy on the quality of care was analyzed in a healthcare unit. Simulation techniques have been applied to manpower planning and scheduling in call centers [2]. Stochastic models, especially queueing models, have been successfully used in manpower planning under uncertainty [3]. Artificial Intelligence has also been used for human resource management, e.g., genetic algorithms for cabin crew scheduling [4].

IV. MATERIAL MANAGEMENT AND DEMAND FORECASTING

In the case of material management and demand forecasting we see from Table II and Fig. 4 that generally quite high volumes of papers come from the healthcare area across the different methods. However, there are generally less academic papers concerned with healthcare (see Fig. 3). Again, simple approaches are the most popular across the board. In this case, most patents are for simple statistical methods.

TABLE II
MATERIAL MANAGEMENT AND DEMAND FORECASTING MODELS

Method type	Industry	Google Web	Google scholar	Scopus	Scopus web	Scopus patents
Artificial intelligence based methods	All	451000	16910	410	17943	943
	H/C	235900	5550	12	11642	355
Simulation methods	All	360000	11800	332	16255	488
	H/C	178000	4320	4	10254	193
Mathematical Programming methods	All	127000	6980	104	8430	283
	H/C	63200	2470	0	5205	52
Stochastic methods	All	125000	5760	99	7913	141
	H/C	66000	1810	1	4811	38
Game theoretic and economic methods	All	47100	1870	11	3346	35
	H/C	32200	905	0	2456	25
All: All industries, H/C: Healthcare industry only						

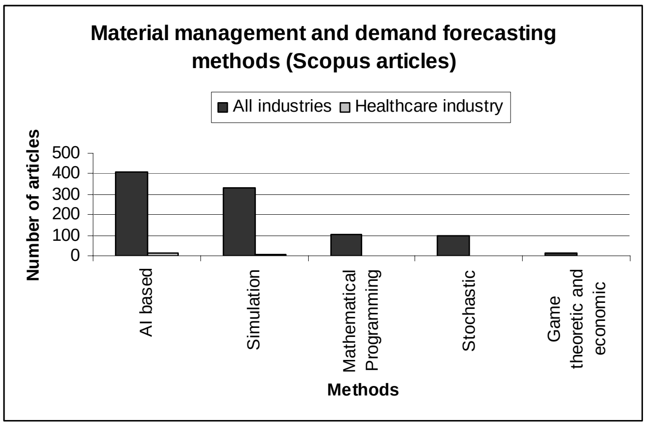

Fig. 3 Comparison of various material management and demand forecasting models in the academic literature (Scopus)

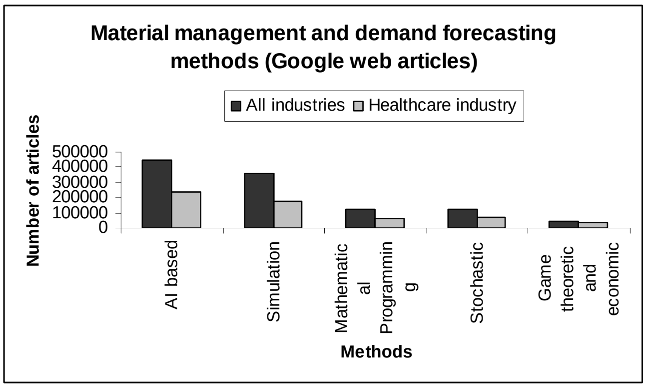

Fig. 4 Comparison of various material management and demand forecasting models in the grey literature (Google web)

A heuristic search technique for material requirement planning (MRP) has been proposed [5]. Mixed integer linear programming was used for MRP systems in the manufacturing industry [6] whereas simulation has been employed for a MRP system [7]. Stochastic models include queueing methods [8].

V. Inventory Planning and Supply Chain Management (SCM)

As for material management and demand forecasting models, inventory and SCM methods have not been of much of academic interest in healthcare (see Fig. 5). However, as we see from Table III and Fig. 6, generally these topics are popular in healthcare. Again, simple approaches are the most popular across the board. In this case, most patents are for Mathematical Programming approaches.

TABLE III
Inventory Planning and Supply Chain Management Models

Method type	Industry	Google Web	Google scholar	Scopus	Scopus web	Scopus patents
Artificial intelligence based	All	2069000	61480	2499	52770	394
	H/C	899000	25790	42	28258	101
Simulation	All	2040000	137000	2850	51450	295
	H/C	220000	61400	42	25038	162
Mathematical Programming	All	730000	20300	1624	24146	87
	H/C	315000	600	12	9658	27
Stochastic	All	1180000	32800	1215	51691	2630
	H/C	605000	8800	8	26729	781
Game theoretic and economic	All	376000	12200	245	23268	93
	H/C	214000	5410	4	15195	37
All: All industries, H/C: Healthcare industry only						

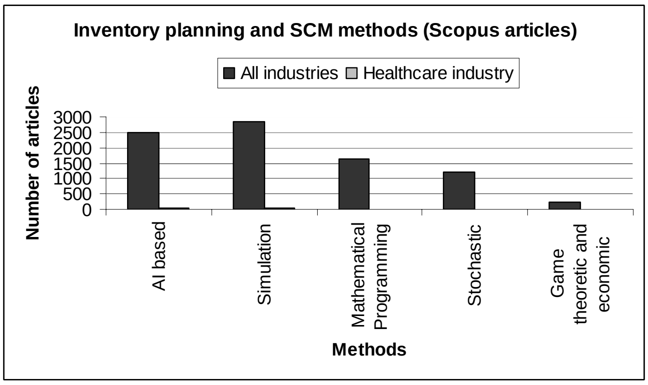

Fig. 5 Comparison of various inventory planning and SCM models in the academic literature (Scopus)

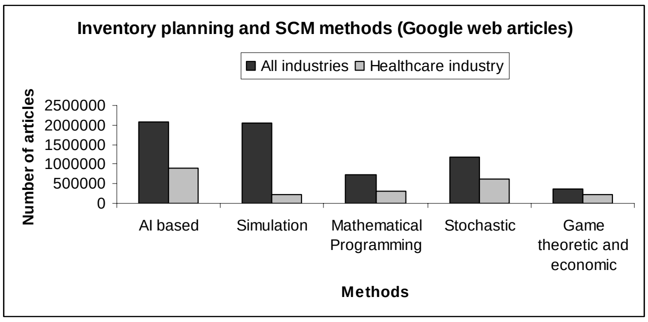

Fig. 6 Comparison of various inventory planning and SCM models in the grey literature (Google web)

A simulation based approach has been proposed to evaluate an information sharing policy in a supply chain management system [9]. Stochastic models are also an attractive choice for modelling supply chains with stochastic demand [10]. Mathematical programming approaches are also common e.g., dynamic programming has been used for dynamic lot size inventory planning [11].

VI. Planning, Process Improvement and Quality Control

In Table IV and Fig 8, we see that generally a lot of agile methods in use are in healthcare. However six sigma, TQM and lean have not had such a good take up in healthcare, relative to other industries (see Figs. 7 and 8).

Naylor et al. [12] discussed how agile methods can be integrated into the total supply chain whereas a six sigma implementation has been described in [13]. Total quality management and its impact on organization efficiency is an important area [14]. Likewise lean manufacturing can have a big impact on organizational performance [15].

TABLE IV
PROCESS IMPROVEMENT MODELS

Method type	Industry	Google Web	Google scholar	Scopus	Scopus web	Scopus patents
Agile methodology	All	21200000	146000	3249	62729	95
	H/C	17710000	85900	32	30987	13
Six Sigma	All	2060000	26300	904	38191	111
	H/C	30000	4200	46	16732	102
Total Quality Management (TQM)	All	2020000	89400	4962	37740	4
	H/C	390000	50200	540	13980	3
Lean manufacturing/ production	All	2080000	19400	1098	18632	22
	H/C	30000	4100	43	8593	4
Continuous improvement/ kaizen	All	4320000	29200	2489	61250	61
	H/C	2070000	5200	116	27817	23
Concurrent engineering	All	742000	32200	4586	11113	12
	H/C	190000	5500	37	3437	1
Business process Reengineering	All	3670000	154000	4008	114783	148
	H/C	1330000	62700	153	44721	32
Theory of Constraints	All	504000	4950	354	3906	6
	H/C	130000	1140	9	1499	2
Statistical process control	All	1010000	23500	3734	7658	22
	H/C	383000	6800	57	3604	2
Integrated Product Teams	All	153000	2690	100	1300	0
	H/C	67900	810	5	647	0
All: All industries, H/C: Healthcare industry only						

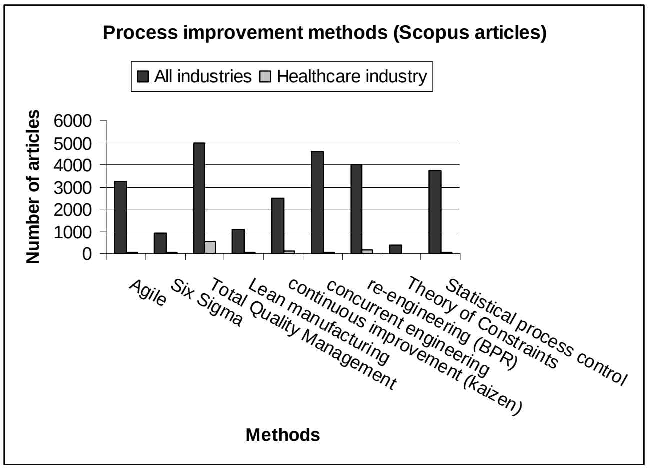

Fig. 7 Comparison of various process improvement methods in the academic literature (Scopus)

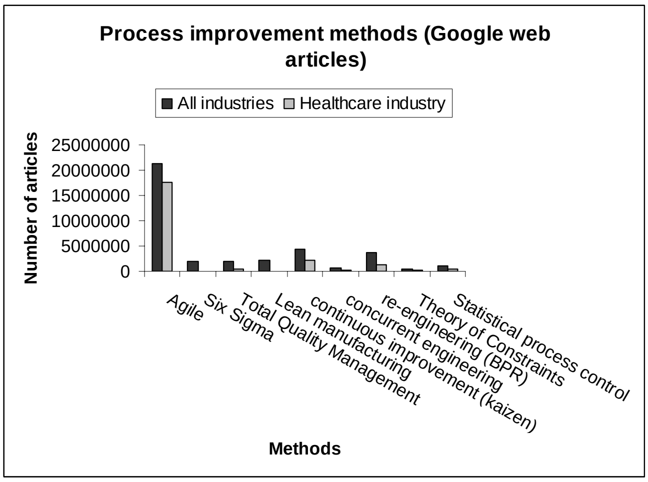

Fig. 8 Comparison of various process improvement methods in the grey literature (Google web)

VII. RESULTS AND DISCUSSION

Our survey has found high proportions of publications in the healthcare area across a range of different methods, with some notable exceptions. In particular, more complex methods (stochastic models and mathematical programming) are less common in the academic healthcare literature. This is a rather surprising finding which may indicate that practitioners can learn from academics that simple approaches may be adequate and complexity is not always necessary. Also significant improvements may be made by academics focussing more on complex approaches with corresponding knowledge transfer to healthcare practitioners.

Our study shows that the take-up of process improvement methods such as six sigma, TQM and lean thinking within healthcare is disappointing. We believe that there are three key dimensions to value in healthcare: clinical, operational, and experiential, and the absence of a single customer with a clear concept of value is perhaps the most important issue for the successful adoption of these methods for healthcare. Therefore, in order to fully incorporate such approaches into healthcare, we should engage with these multi-dimensions of value and modify the concepts accordingly.

VIII. CONCLUSION AND FUTURE WORK

The results of this survey demonstrate that there are areas where healthcare practitioners and academic researchers are using management science approaches in a similar way to other service and manufacturing industries. However, there is still there is a gap which require urgent attention to help improve healthcare service management and planning decisions. Academic researchers can hugely contribute to such developments by properly identifying the concepts and need for improvement and suitably adapting the management science methods for healthcare problems.

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