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# Deriving research agendas for manufacturing and logistics systems: A methodology

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ABSTRACT

The paper describes a methodology to help systems analysts identify and prioritise an organisation's manufacturing and logistics problems and determine the changes that the organisation needs. The problems and associated investigations form the research and implementation agendas. The methodology considers the manufacturing system functions of a company to be part of a concurrent enterprise. It then uses the concurrent enterprise model in conjunction with an unconstrained Activity Matrix (AM), which shows the activities of the system that converts physical inputs and plans (stated or implied) into the important variables and system performance measures which are called attributes.

The methodology uses an Activity Matrix (AM) to produce a Problem Matrix (PM). From this, a Tentative Research Matrix (TRM) is produced, and subsequently a Research Matrix (RM) is developed. Then the RM activities are prioritised to create the Research Agenda (RA).The sequence of steps is AM ⇒ PM ⇒ TRM ⇒ RM ⇒ RA.

The research agendas methodology is developed in the broad fields of logistics and production and operations management. The paper tests the proposed methodology using the function of production planning and control.



## 1. Introduction and context

Organisations seek to improve their performance. In addition to responding to environmental factors, social issues and legislative constraints, the highly competitive globalised market requires that organisations make frequent product changes, shorten product development times, shorten product lead times, meet stringent quality requirements and make decisions that are right first time. These requirements have consequential implications for the company's manufacturing and logistics systems. However, it may be difficult for a company to select its response to the ongoing changes and to decide which problems, if any, to investigate. The set of activities/problems that are selected to investigate is called the research agenda. When the emphasis is on implementation, the activities and required changes form an implementation agenda. The paper presents and evaluates a general methodology that can derive relevant research agendas.

This research examines how to design sustainable logistics systems. Although an operations manager may wish to use 'quick and dirty' studies to overcome immediate problems, some problems are more fundamental and need to be identified and tackled systematically. A generic life cycle context is used to present the methodology that relates particularly to logistics problems that need systematic investigation. The fields of applicability include manufacturing and logistics system design, production planning and control, inventory planning and control, quality control, information systems and performance measurement.

During the formulation of the methodology, members of the research team aired the ideas in internal discussions and in working papers. Eventually the project was subdivided into the following parts:

- Identify the context for examining the economic and environmental performance of logistics systems. This was discussed in Bonney and Jaber (2011).
- Produce an input–output representation to analyse the economic and environmental aspects of production inventory systems. This was discussed in Bonney and Jaber (2013).
- Present a methodology to derive research agendas to improve manufacturing and logistics systems performance. This is discussed in this paper.
- Investigate performance measures with particular emphasis on metrics for sustainable logistics. This work is in preparation.

Section 2 summarises work on developing methodologies for production and operations management. The paper then describes

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the methodology for deriving research agendas for manufacturing and logistics systems and uses the Production Planning and Control (PPC) function to illustrate its use. Section 3 examines the PPC function, while Section 4 provides a framework for production management. Sections 3 and 4 provide a context for describing the research agenda methodology in Section 5 and then developing and evaluating a research agenda for PPC in Section 6. Section 7 expands the discussion of Section 6 to highlight the need for developing appropriate performance measures for PPC functions. Section 8 discusses how the proposed methodology could develop research agendas for other planning and control functions and operations management within a complete manufacturing system or logistics system. The paper summarises and concludes in Section 9.

## 2. Research agenda studies in production and operations management

To develop a research agenda is a challenging task, particularly for fields like Production and Operations Management (POM) which "evolved from a purely descriptive origin through the Management Science/Operations Research [MS/OR]" (Buffa, 1980), and which undergo continual and radical changes resulting from the dynamic nature of the market in which systems operate and with which they interact and the major changes that occur in products, materials and internal and external systems. These changes require research agendas continually to evolve. To the authors' knowledge, the earliest studies that could be viewed as research agendas are those of Buffa (1980) and Chase (1980), which appeared in the inaugural issue of the "Journal of Operations Management". Buffa (1980) stressed that in order to develop a research agenda for POM, the following questions must be answered: (1) Where have we been? (2) Where are we? and (3) Where should we be? Chase (1980) proposed a two dimensional framework for classifying current and future research in POM: Research Emphasis and Research Orientation. Research Emphasis represents rows (people and equipment), while Research Orientation represent columns (Macro and Micro) in a $2 \times 2$ table. Macro level research and field case studies were scarce. Amoako-Gyampah and Meredith (1989) reviewed the state of POM research through a survey of published articles in specific POM related journals and conference proceedings. Their study showed that inventory control systems and aggregate planning and scheduling was the most researched area (57% of 362 articles in 17 POM categories), while 21%, 15%, and 7% of the articles addressed productivity and technology, operation policy and service category, respectively. They concluded that POM research mostly used mathematical modelling and simulation experiments. An absence of integrative and co-operative research was clear. Amoako-Gyampah and Meredith (1989) further added that in order to develop research that is managerially applicable, a new paradigm of POM research must be developed. Later, Meredith (1993) stressed that there is a dearth of theories in POM that allow the formulation of hypotheses and testing of propositions. He argued that the use of conceptual research methods, which are based on descriptive and empirical investigations, increases the validity of POM research conclusions and acceptance by managers. In his survey of POM theory building methods, Meredith (1993) describes a normal research cycle as starting with the description stage followed by explanation and testing stages, with each stage resulting in a model. This iterative process continues to develop a research framework and theory. Ignoring any stage disconnects the developed model from reality by making it less relevant and appealing to managers. In his survey of 362 papers, Meredith (1993) found that conceptual research methods represented 14%, theory testing (modelling, simulation and laboratory experimentation) 70%, and case and field studies and surveys, 16% of the articles.

Neely et al. (1995), which was reprinted in 2005, focused on the performance measurement system design, which was lacking from earlier studies. They defined performance measurement as the process of quantifying the efficiency and effectiveness of an action, and a performance measurement system as the set of metrics that is used to measure the efficiency and/or effectiveness of actions. The implemented performance measurement system, which has to interact with its environment, has two fundamental dimensions: internal (the organisation) and external (its market). This paper was updated in Neely (2005) in which he took another approach by using citation/co-citation analysis of publications to identify the key contributors to the field. Neely's analysis was able to show that performance measurement research in 2005 was entering the phase of empirical investigation and theoretical verification of some of its core concepts.

Economic growth and prosperity come at a cost to the sustainability of the environment and its quality. Bloemhof-Ruwaard et al. (1995) proposed incorporating operations research into Environmental Management (EM) principles to develop a research agenda for sustainable production and OR. The term "Green Supply Chain" appeared in their paper as the integration of the physical chain and the environmental chain. The end-of-pipe waste and pollution generated from the first chain are the inputs of the second, which are dispersed and transformed potentially affecting air, soil and water leading to reduction and damage of primary resources. Bloemhof-Ruwaard et al. (1995) suggested shifting POM policies from being corrective to being preventive and to expand the environmental policy in both its content and scope. They concluded that integrating OR and EM raises promising research opportunities to develop models and methods that cope with product recovery and management in the physical and environmental supply chains. They anticipated that OR will integrate with related sciences to "use tools like life cycle assessment, economic input–output modelling and systems analysis".

Beamon (1998) provided a focused review of the multi-stage supply chain modelling literature and used the review to define a research agenda. She defined a supply chain as the integration of the planning, inventory control and the distribution and logistics processes. She classified the literature of the supply chain models (methodology used) into four categories: (1) deterministic analytical models, in which the variables are known and specified (2) stochastic analytical models, (3) economic models, and (4) simulation models; the performance measures used into four categories: (1) cost, (2) customer responsiveness/backorders, (3) activity time, and (4) flexibility; and the decision variables into eight categories: (1) production/distribution scheduling, (2) inventory levels/ordering (batch) size, (3) number of stages, (4) DC-customer assignment/location, (5) plant-product (assignment), (6) buyer-supplier relationship, (7) product differentiation step, and (8) number of product types held in inventory. These classifications (16 columns) and the surveyed papers (24 rows) were organised in a table of $24 \times 16$ cells. Where applicable, a cell marked by "X" indicates that a specific paper adopted this or that methodology, performance measure and decision variables. This made it easy for a reader to clearly identify the research gaps (empty cells). Beamon (1998) was able to identify four areas of supply chain research that are needed to aid the design and analysis of manufacturing supply chains. These are: (1) evaluation and development of supply chain performance measures, (2) development of models and procedures to relate decision variables to the performance measures, (3) consideration of issues affecting supply chain modelling, and (4) classification of supply chain systems.

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