



## Research paper

# Identifying organizational requirements for the implementation of Advanced Manufacturing Technologies (AMT)

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## ABSTRACT

AMT selection and adoption processes have been extensively studied. Topics that include financial and human factors, productivity, and coordination of the AMT implementation establish a substantial content of the present research agenda. The purpose of this paper is to study the organizational factors that influence the AMT implementation, considering a manufacturing strategy context and an analysis based on an organizational design framework. The research strategy is based on 'empirical iterations' using survey secondary data, experts' interviews information and multiple case studies. The results show that there is a set of recommendations, which strongly influence the AMT implementation. Companies require a structured and integrative approach for the AMT implementation in order to take advantage of all their individual and systemic benefits. The set of proposed AMT recommendations for integrating these technologies to the organizational design are framed by structural, process and contextual aspects.

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## 1. Introduction

The process of introducing a new technology into a company's operations systems makes changes in organizational structures, processes and spaces; firms face obstacles during its implementation phase. All these elements refer to a new organizational architecture in such a way that these changes may be addressed through organizational design reviews. This paper explores the introduction of 'Advanced Manufacturing Technologies' (AMT), which are the subject of those changes, that is, their adoption and/or implementation involve changes in the organizational structure, processes and spaces. These technologies can be regarded as resources used by companies to develop higher levels of performance and competitiveness.

In the present paper, AMT are approached through a bought-in perspective or according to the resource-based view (RBV). Even though, other perspectives are recognized in terms of a product-service definition. A Product-Service System (PSS) is a special case of servitization, which can be thought as a market proposition that extends the traditional functionality of a product by incorporating additional services [1].

Currently, AMT are still chosen predominately according to operational criteria aiming, for instance, to solve problems related to quality, productivity, safety and reliability performance. AMT can indeed provide competitive advantages for companies, and in doing so, these technologies should to be selected according to strategic criteria [2–7].

When organizations integrate their production systems (e.g. through automation), they encounter problems regarding the identification of a model for the organizational design. This model should be compatible with the adopted technological resources and external market requirements. The availability of new technologies such as the AMT and the associated possibility of their use as competitive weapons forces companies to reorganize their operations systems motivated by the technological update. As in the studies based on technological innovation that specifically evaluate the introduction of new technologies, the importance of the compatibility of the organizational design with the technology being introduced is highlighted [8–16].

Woodward [17–20] sought to evaluate whether management principles had an impact on business performance or not. One of the researcher's outstanding studies and statements on the influence of technology still influences the organizational design of companies:

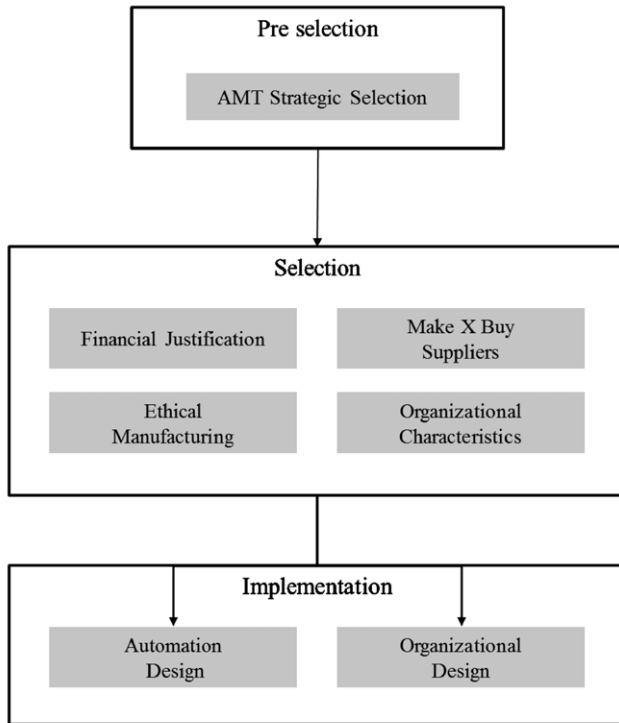
- The organizational design is affected by the adopted technologies;
- There is a strong relationship between organizational structure and the 'consistency' of production techniques;

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Source: Gouvea da Costa [21]

Fig. 1. AMT selection model.

- Organizations with stable operations require different structures from those organizations with shifting technologies;
- There is a predominance of functions in organizational models.

The research of Woodward [17] revealed dependence relationships regarding the technology adopted by the organization and its environment. External circumstances and the technology being used determine requirements for the organizational design. Based on the AMT selection model developed by Gouvea da Costa [21] and presented in Fig. 1, this study intends to identify which organizational characteristics should be considered in the AMT adoption. These elements can guide the process of organizational changes, that is, they can represent the foundation for the organizational design review.

Considering that the research presented in the paper is in the Operations Management and Industrial Engineering domain, the research question favors a qualitative approach due to its constitutive inquiry characteristics. Hence, it seemed appropriate to investigate the relationship between the company and the technology to be introduced through empirical data. The research strategy adopted in the study is based on the development of a theoretical framework, analysis of standard industrial survey secondary data, experts' interviews and case studies. The process uses an iterative approach that allows the identification of a set of organizational characteristics, which mediate the AMT adoption.

The refined synthesis framework, that is, the product generated by the study is based on the authors' prior research and published literature. The paper is organized as follows: (1) research methodology, which defines the research strategy and the sequence of iterations including the literature review; and (2) the generation of recommendations based on successive iterations.

## 2. Research methodology

The study was based on an exploratory approach to achieve the main objective of generating recommendations on the organizational design review for the AMT adoption. It started with a review of relevant literature. The main purpose of the literature review was the generation of an initial list of recommendations for the organizational change. This list was the object of successive refinements in each phase of the research plan through the iteration process (often used in the Social Sciences), resulting in a refined list of recommendations.

The study is qualitative by nature and its strategy mobilizes different techniques. Research propositions and questions are used instead of formal hypotheses. The research questions lead to particular data gathering strategies. As data accrue, the analytic strategy begins inductively as the researcher works to understand the meaning of the variables. Relationships between variables emerge and are analyzed to consolidate information produced in the early stages of the research. This alternating cycle of induction and deduction is termed iterative, recursive, or abductive. Moreover, this process leads ideally to considerable flexibility in revising the research design, interview questions, and other data gathering and analytic strategies. It is necessary to ensure that the data is complete and results are rich and descriptive [22].

In recent years, the iterative process has been more often used in Operations Management due the frequency of technological change and the evolution of management practices. Lewis [23] proposes iterative triangulation on a systematic basis covering literature review, evidences from case studies and the insights and perceptions of researchers. The research process was divided into four phases:

- Groundwork that covers literature review and the selection of cases;
- Induction that encompasses the case analysis and formulation of statements;
- Iteration for the refinement of statements;
- Conclusion for theory assessment and formulation of future research guidelines.

Four phases were proposed for realizing the selected research strategy. From the literature review a theoretical body was developed, and it was also possible to identify preliminary organizational characteristics. Phase 1 generated a list containing the main problems and recommendations observed in the process of (a) AMT selection, (b) AMT adoption and (c) AMT implementation.

Once this list was produced, the first iteration was realized. The theoretical recommendations were tested and analyzed using secondary research data. These secondary data sources were constituted by the following study results: "A study of the organizational 'barrier' to the introduction of new technologies" developed by Cardoso et al. [24], and an "Industrial Survey" developed by the Federation of Industries of the State of Paraná (FIEP) in Brazil [25–31]. After the analysis of secondary data, a second list of refined recommendations was obtained.

The second iteration was based on interviews with practitioners of automotive and metal-mechanic companies, who had taken part in processes of AMT selection, adoption or implementation. As a direct result of the analysis of these interviews, a third list of recommendations was generated. Eight professionals from the Engineering and Manufacturing areas were interviewed. These practitioners belonged to three hierarchical levels as presented in Exhibit 1. The interviews lasted approximately one hour. A semi-structured script was followed. The script was based on the report of the interviewee's previous experience and the analysis of his/her company's technical documentation.

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