

How Can MES Improve Organizational Performance? From a Perspective of Synergy Building and Organization Design

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Abstract

Many MES-introduced organizations did not realize the return on investment, improve efficiency. There was little research in academia. This study intended to uncover the underlying reasons, to explore whether organizational design and the formation of synergy can improve the efficiency from breaking through information faults, data silos, improve performance by integration different systems and business processes, by facilitating communication and coordination across all functions. This study was to conduct a multiple case comparative case study. The findings would show unimpeded information made systems worked well together, the quality of asset operation was improved and the cost was reduced, so production and sales increased. This study contributes to the literature by expanding success factors, reporting on the real application status and smart manufacturing optimization strategy, which renewed people's understanding. The results touch some real situations, which are relatively pertinent and easier to be understood and accepted by enterprises in practice.

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Introduction

"Intelligent manufacturing" has become a hot topic in the manufacturing industry, leading a wave of digital revolution. At this frontier, the manufacturing execution system (MES) has emerged as a key tool to promote intelligent production. The application of MES system indicates that the manufacturing industry is actively meeting the challenges of the digital era. MES is in the core layer to fully support enterprise operation and control. It must achieve orderly, coordinated, controllable, and efficient manufacturing execution. However, the failure of the organizational transformation obviously had a lot to do with the fact that it is not working as well as it should. Lack of digital knowledge, insufficient personnel capacity, and no restructuring of the processes, simply it had been introduced for investment's sake. The management model has not changed with these changes and digitalization. Information silos were created within the organization, and cross-functional and human-machine collaboration were ineffective. To maximize performances and profitable margins, not only have different technology systems connected into an efficient network (Ardeshir Shojaeinasab, Todd Charter, Masoud Jalayer, et al, 2022), but also the whole manufacturing system need to be made innovations (Ihab Ragai, 2021). Market demands force manufacturers to increase productivity daily, and MES provides an intelligent structure for actual output execution. Factors such as reducing scrap, increasing uptime, and reducing costs are the top reasons for innovation.

Considering all these scenarios, the questions to be answered are: How can a manufacturing company achieve outstanding performance and enhance long-term competitiveness from MES by forming synergy at the entire organizational level? The purpose of the study is through multiple case comparative study to explore whether the integrated degree of MES with other technologies and adaptability with business processes could impact organizational innovation performance? Will it give any insights for those organizations already introduced MES to make best use, and for those in the early phase of planning to introduce and deploy the MES initiative?

Literature Review

Synergy

Synergy, which borrowed from Greek, originally means "working together". In business sector, departments coordinate and collaborate will produce greater outcomes than if done alone. Porter (1987) defined synergy as one of the advantages for competition on the condition that primary activities such as human resources, teamwork, technologies and innovative systems, and organizational setting and environment etc. supportive activities meet. Greater value would be created if genuine synergy could be formed. An organization could create much more rewarded value by a well-defined approach of best use of extant capabilities and resources (Dennis Irwin, 1989; Kaplan, Norton, 2006). Information technology systems are used to serve business process to improve organisational performance. Ling, H., Zhao, F., & Wang, Y. (2009) argued the synergy of IT and business process produces organisational ambidexterity capability, which was conducive to organisational performance. Synergy could be achieved by a well-functioning and continuously learning teams, or two or more teams have something could be complementary in demand (Jasinska 2019; Tantalo, C., & Priem, R. L., 2016). Another aspect of synergy represented by partnership functioning dimensions, particularly leadership effectiveness and partnership efficiency. Partnership's collaborative process successfully combines its participants'

perspectives, knowledge, and skills (Elisa S. Weiss, Rebecca Miller Anderson, Roz D. Lasker, 2002). “Each team collaborates effectively to achieve strategically important objectives”, clarified Later Wither and Chau (2010). The synergy model comprises four perspectives, i.e. strategic, cultural, operational, and commercial (Bititci, U., et al. (2007).

A review of synergy literature showed that research in the previous study mainly focused on impact factors, taking for example collaboration, continuously learning, innovation, teamwork etc., could affect synergy outcome. Commonly used methods are case studies and other quantitative research methods (Ayca Altay, Gulgun Kayakutlu. 2012). In conclusion, more and more research has been shifted from impactors to strategic perspective. However, there is a lack of its application in the digital transformation setting. This study will inquire into what the organization-level performance outcome would be if digital technologies, data analytics and operations management could be integrated by a holistic approach with existing contingencies.

Organization design

Organizational design refers to the process by which managers combine various elements of an organization to establish and implement a specific organizational structure. Organizational design is one of the necessary means of effective management. Organizational design is a dynamic process that encompasses a wide range of tasks. Scientific organizational design should be carried out step by step according to the internal regularity of organizational design, to achieve good results. There may be three situations in organizational design: 1) the new enterprise needs to be designed for organizational structure; 2) the original organizational structure needs to be re-evaluated and designed if there is a big problem in the original organizational structure or the goal of the enterprise changes; 3) the organizational structure needs to be partially adjusted and improved.

The resurgent trend of organization design research is organizational strategy, innovation, performance (Joseph, J., Baumann, O., Burton, R.M., & Srikanth, K.P., 2018), and innovation (Sengul, M. (2019).

The synergy theory emphasizes that to achieve best outcome, an organization needs to make best use of internal resources and at the same time establishes reliable partnership with outside stakeholders, while the theory of organization design focuses on restructure organization to achieve outstanding performance. The former theory is all about culture, while the latter one is about innovation.

In reality, quite a lot of enterprises failed to get investment returns from digital transformation initiative, what they cared about most is technology and they did least in fitting the change into business models (Behnam Tabrizi, Ed Lam, Kirk Girard, Vernon Irvin, Kirk Gerard, 2019). For a manufacturing organization, MES is a coral infrastructure in already transformed or in the process of digital transformation, the success of the organization depends on the effective and efficient application of MES. These two theories have provided us a new perspective study into MES performance, a typical characteristic is to combine culture mindset of synergy and innovation essence of organization design theory into one methodology to solve the nagging problem faced by most manufacturing companies.

Manufacturing Execution System

In order to have a better understanding of research status on MES, the author used Semantic Scholar, CORE and CNKI to search some 500 hundred articles, across an interval of from formulation of construct to the present. To have a high-quality data, all dissertation, newspaper articles, and low-ranking impactor journal articles had been excluded, 300 or so journal articles had been used. All these papers had been grouped into 3 three categories, impactors to, components of, applications and implementation of MES.

Since its coming into being, through decades of the development, the MES has entered the second stage both academically and practically, the smart stage.

The topics in the 1st stage were about its position in a hierarchy of information communication system (ICT), its functions and function add-ins (De Ugarte BS et al.,2009). As early as 1970s, it had been conceived to be a tool collect and display real time data to complement ERP for decision-making (M. McClellan, 2001). The execution status of production scheduling, quantities consumed of materials and components both inbound and outbound, operation status of online machines and equipment, including ratio of finished goods, etc. data of these kinds, not sporadic but continuous trend one was its main objectives (Ardeshir Shojaeinasab, Todd Charter, Masoud Jalayer. et al., 2022).

In the 2nd stage, according to the studies of Snoeij,J.(2006) and Yu, Wu., Xiao Dong, X., Cong Xin, L.(2009),the functions of MES have been expanded into 11 categories and have been adopted widely in plethora of industrial settings. Along with its boom, many vendors have participated in the competition, manufacturing enterprises have more applications to choose from (J. Kletti, 2007). Research on MES has been directed to how smart it could be, by integrating typical technologies ever since the advent of industrial 4.0 era. In the new context, as Jasko S, Skrop A, Holczinger T, et al (2020) argued that the roles have been changed. The manufacturing industries have expected more from it by integrating AI, digital twin, augmented reality, RFID, so as to make its smarter than ever, such as improved performance, quality and agility etc (Q. Chang, J. Ni, P. Bandyopadhyay, et al, 2007; Kritzinger W, Karner M, Traar G, et al, 2018; F. Almada-Lobo, 2016; Sherwin Menezes, Savio Creado, Ray Y. Zhong. Et al. 2017; H. Lasi, P. Fettke, H. G. Kemper, T. Feld, 2014). Another direction is how to connect vertically and horizontally with other intelligent systems and devices, through IoT, WIFI, and 5G network (Tongsuksai, S., Mathrani, S. 2020). With faster speed, more data generated during intelligent manufacturing processes, cloud computing has become necessary (Liu, Y.Y., Hung, M.H., Lin, Y.C., 2018). To make operation strategy more accurate and precise, colossal data called big data must be real time analysed and transmitted for decision-making (Wang, S., Wan, J., Zhang, D., et al. 2016). With the continuous evolution of new production modes driven by intelligent manufacturing technology, MES is developing in the direction of intelligence and platformization that is more suitable for new production models. Being able to provide solutions for the integration of processing, logistics, and control technologies for modern workshops will be conducive to the transformation and upgrading of manufacturing enterprises. It is necessary to expand the scope of the manufacturing operation management system from the manufacturing site to the product design at the upper level, the manufacturing supply chain, and the intelligent equipment level at the lower level (Mantravadi, S., Srai, J.S., & Møller, C. 2023).

The literature review indicated not much effort has been focused on the compatibility between different technology structuring, to form synergy (Yli-Ojanperä M, Sierla S, Papakonstantinou N, et al. 2018). For research methods used in the above-mentioned literature, almost all of them adopted empirical study methods, such as experiments, quantitative study, and mixed methods. Qualitative methods have been used the least. Few research has studied organizational performance brought by effective and efficient use of MES system. So study focus on organizational performance by delving into actual use scenarios of MES and provide practical implications by using a theoretical framework combined by synergy and organization design.

Research Methodology

Multi case study is often used to build theories, for a case is an indiscrete experiment, and three cases can serves replication, contrast and extension to emerging theory (Eisenhardt, 1989; Yin, 1994; Eisenhardt, K.M., & Graebner, M.E. 2007). This study's selected cases were as follows. Case 1 is a state-owned iron and steel enterprise, a leading enterprise in the domestic market belonging to heavy industry, more than 8,000 people, worldwide annual sales of 30 billion RMB. Case 2 is also a state-owned chip manufacturing enterprise with about 2,000 employees, worldwide annual sales of more than 100 billion currency, and is a first-class high-tech enterprise in China. Case 3 is a microfiber manufacturing company listed on the Shanghai Stock Exchange, with 250 people and sales of 500 million yuan a year. All three organizations have completed their digital transformation and present high operational and financial performances.

Besides publicly reported data and information, interview, face-to-face interviews and telephone calls, videos, and e-mails shall be considered. Cluster coding and axis coding formed by successive coding constitute the variables in the analysis process. Then the quality of inference can be guaranteed.

Based on these two aspects, a greater credibility has been enhanced.

Reliability shall be guaranteed by standardized research process, data collection and data coding. This study ensures internal validity by ensuring the consistency of data-results-conclusions. A triangular measurement is used to detect and ensure the construct validity of the study.

NVivo 23 software was used for data analysis. The unit of analysis for the study is the degree of integration of MES with other technologies and adaptability with business processes.

Comments on How to Develop the Paper

Phase 1

Time: March 1, 2024—June 30, 2024

Content: data collection and data analysis

Phase 2

June 30, 2024—September 30, 2024
Content: paper writing

Findings

The reporting and analysing of finding contents are still waiting to be structured in a clear, logical and easily understood manner.

Discussions and Conclusions

Although understanding and addressing the relation of the findings to the goals, questions and hypotheses is still ongoing.

The originality of thought can be demonstrated as the contribution and practice implication of this study are as follows. First, this paper selects MES, the key system of digitalized enterprise as the basic system of how to plan, operate and maintain in the process of digital transformation. The author reports on the real application status of MES systems in the manufacturing industry and how the generated data is used, which renews people's understanding of MES. For each potential problem situation, the corresponding problem-solving direction is provided. Next, MES could not be regarded as a standalone system, digital mindset and culture must be cultivated, business processes must be restructured based on the digital infrastructure looking at the future, the best outcome comes from synergy from the stakeholders, and from restructured business processes. Thirdly, this paper conducts the research on the digital transformation and upgrading of enterprises by focusing on the manufacturing execution system. It analyzes the implicit relationship, uses MES to reengineer the business process of enterprise value creation, and coordinates the process of enterprise digital transformation. This makes it easier to find the problems in the transformation process, lays a foundation for the continuous optimization and improvement of enterprise transformation, and enriches the understanding of enterprise digital transformation in the existing research to a certain extent. Finally, MES introduction and operation success factors are supplemented to take account of digital skills, digital experience, compatibility of digital technologies, value creation process restructuring and data analytics of the users.

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