A Review of Barriers for the Adoption and Implementation of Cloud Manufacturing in Current Manufacturing Scenario

Mahesh
PhD Research Scholar in Mechanical Engineering Department
YMCA University of science and Technology, Faridabad.

Dr Bhaskar Nagar
Faculty in Mechanical Engineering Department
YMCA University of science and Technology, Faridabad

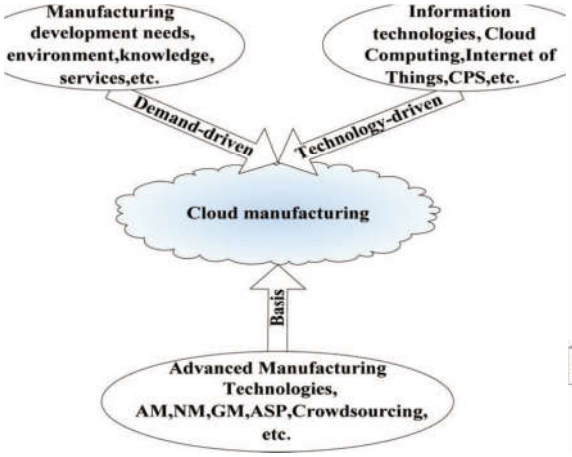
Abstract: **M**anufacturing organisations standardised tools and techniques to realise process improvement. This paper seeks the root causes of failed implementations and considers how these may be overcome. The paper begins by reviewing various paradigms for manufacturing systems improvement. In addition to examining the knowledge requirements of different approaches, the barriers to realising improvement are examined through consideration and review of literature from the fields of manufacturing, management and information systems. The review reveals the importance of fundamental understanding and highlights the lack of current methods for generating such understanding. To address these issues, the concept of manufacturing interaction is introduced and a set of requirements for a supportive methodology to generate the fundamental understanding necessary to realise cloud manufacturing process improvement is developed.

Keywords: Cloud computing SME, Internet of things, IoT, E-commerce, TOE Frame, CMS,

1. Introduction

According to problems in the development of manufacturing information, literatures keeps forward the concept of cloud manufacturing based on existing manufacturing models and advanced manufacturing technologies. Cloud manufacturing provides a new idea to solve more complex manufacturing problems and perform larger scale collaborative manufacturing. Cloud manufacturing is a new service-oriented, high efficiency, low consumption, knowledge-based, intelligent networked agile manufacturing model and technology. It enriches and expands the range of resource sharing and service model in cloud computing, promotes agile, service, green and intelligent-oriented manufacturing development. By integrating cloud computing, Internet of things, high performance calculation, service computing, artificial Intelligence and information oriented manufacturing, service system and technical architecture of cloud manufacturing are constructed. The research for cloud manufacturing is still focused on concept, system architecture and so on. Therefore, we study several key issues for cloud manufacturing platform to provide theoretical foundation for realizing more effective and more intelligent cloud manufacturing system in the future [10].

Concept of Cloud Manufacturing: Cloud manufacturing is a network of cloud computing, service computing and manufacturing enabling technologies to transform manufacturing resources and manufacturing capabilities into manufacturing services, which can be managed and operated in an intelligent and unified way to enable the full sharing and circulating of manufacturing resources and manufacturing capabilities. Cloud Manufacturing can provide safe, reliable, high-quality, cheap and on-demand manufacturing services for the whole life cycle of manufacturing [9].



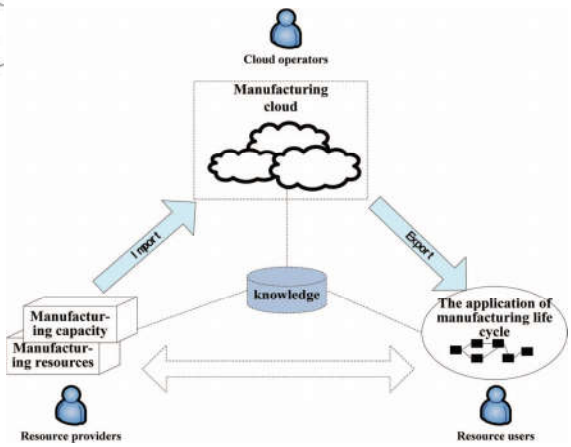


Figure 1. The proposition of Cloud Manufacturing. **Figure 2. The abstract operation principle of Cloud Manufacturing**

1.2 Typical characteristics of Cloud Manufacturing: Providing on-demand services for the whole life cycle of manufacturing, supporting agile virtual organisation/community, intelligent perception of manufacturing resources, Knowledge based intelligent manufacturing, Wikipedia style and group innovation based manufacturing.

2. Cloud Manufacturing service platform and manufacturing cloud

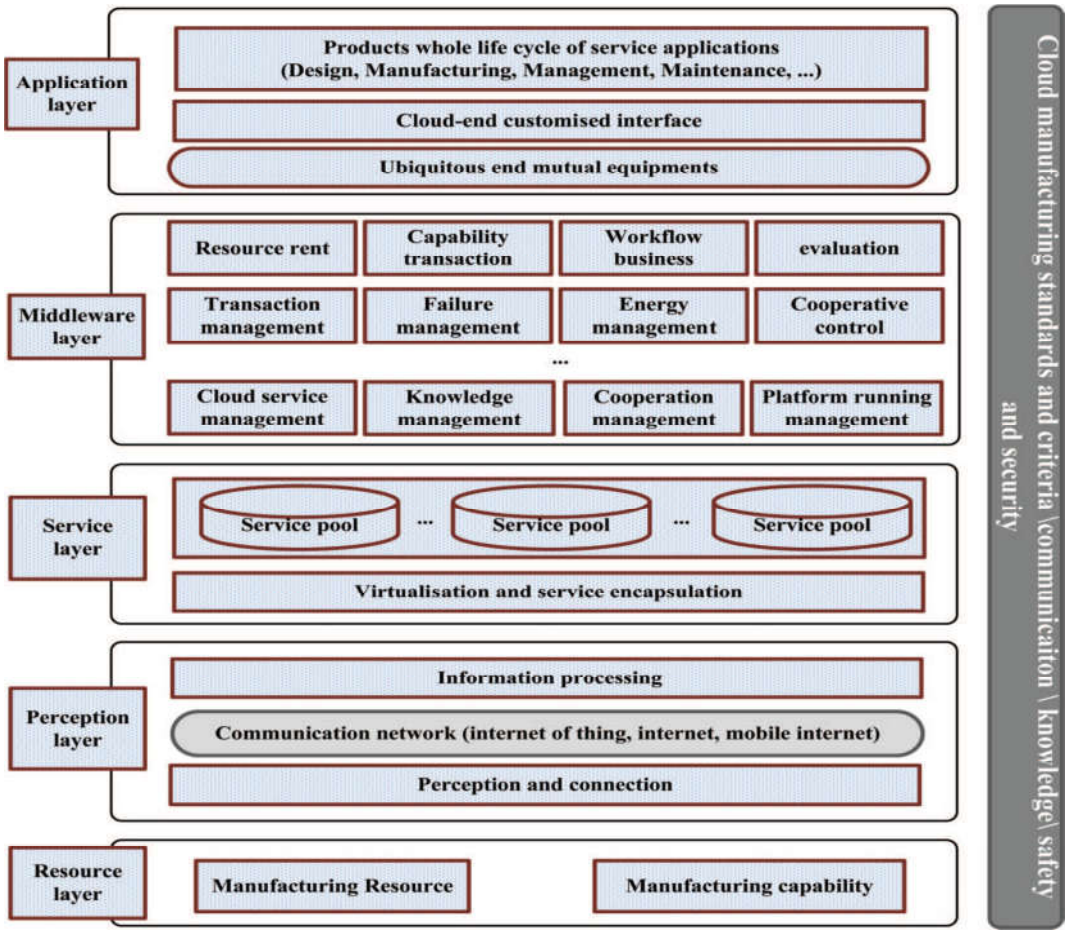


Figure 3. The architecture of Cloud Manufacturing

3. Prototype of Cloud manufacturing platform

Virtualisation-supported subsystem, cloud service management subsystem, knowledge data base management subsystem and cloud services-oriented complex product design subsystem

4. Literature Review

During the past few years, manufacturers had implemented computer integrated manufacturing (CIM) to use computers and communications networks to transform automated manufacturing systems into interconnected systems that cooperate across all organizations functions. Company that have successfully implemented CIM reports several benefits: Faster purchasing processes, reduced business cycle, higher inventory turnover, faster response times and improved services after overcoming the following barriers in CIM environment:- Lack of Management Support, Lack of Effective Organizational Communications, Inadequate Strategic and Business Planning, Rigid Organizational Structure, Lack of IS Involvement, Inadequate cost justification methods, Outdated cost accounting system and Inappropriate selection of vendors [1].

While there exists of publications presenting the successful implementation of different manufacturing improvement strategies (Brown et al. 1994, Sohal et al. 1998, Bamber 1999, Henderson and Evans 2000, Antony and Banuelas 2002, Apte and Goh 2004, Chan et al. 2005) the experiences of the authors and those of the practitioners had worked with that in many initiatives which were failed to meet expectations and can fail to deliver any improvement at all. The existence of only partially successful and failed initiatives was supported by past and contemporary literature, an example of this being Redman and Grieves (1999), who noted that between 70–90% of TQM programmes implemented have failed. An appraisal of the literature reveals six core areas: lack of commitment, reactive organisations, layered initiatives, incomplete implementations, incorrect implementations and resistance to change [2].

Realization of the cloud computing infrastructure requires access to data anywhere, anytime at any device at a sufficient perceived quality of service. In this paper, the combination of e-commerce, cloud computing and broadband infrastructure had focused, and its unique possibilities for the overall IT society. However, it was also about a significant number of Small and Medium sized Enterprises that applies manual billing systems or Excel like systems in combination with severe lacks of sufficient IT skills. This means that the most commonly used systems were the ones requiring the most of time. Therefore, the movement for the SME towards e-commerce and electronic processes had a significant economical potential for the SMEs. E-commerce and other internet based services will simplify their business, and hence allow the SMEs to focus on their core business which was their raison. In addition to this can be added other fundamental IT systems that would help in business, but that was outside the scope of that work. Furthermore, the work focused on infrastructural barriers and cloud computing; not only focusing on bandwidth, but also the entire issue of service offering [3].

Cloud computing solutions will minimize the SMEs investment in own hardware (HW), software (SW) and maintenance. Work done aimed to statistically analyze the drivers and barriers to GM implementation for developed and emerging nations so that the organizations can strategically focus on the factors to reach to a higher level of competitiveness.

Barriers to green manufacturing: Weak Legislation, Low Enforcement, Uncertain Future Legislation, Low Public Pressure, High Short-Term Costs, Uncertain Benefits, Low Customer Demand, Trade-Offs, Low Top Management Commitment, Lack of Organizational Resources, Technological Risk, Lack of Awareness/Information etc [6].

Cloud computing had the potential to speed up IT adoption among SMEs in developing economies. Though the benefits of cloud computing was very appealing, the level of cloud adoption

was low among SMEs. The research aimed to identify the key enablers, barriers and other factors that influence cloud adoption among SMEs in Tamil Nadu by conducting empirical investigations. The TOE framework has been used to identify and capture the factors that affect technology adoption. It highlights the cost benefits of using cloud infrastructure, scalability and agility of cloud services as the key enablers of cloud adoption. Broadband availability, high bandwidth cost and vendor lock-in are the main barrier for cloud adoption. Compatibility to existing system, complexity of the migration process, top management support, government policies and competitor pressure are the major organizational factors affecting cloud adoption among SMEs in Tamil Nadu. The study was a part of a larger study which aimed to develop a cloud migration decision support system (CMDSS) for SMEs in Tamil Nadu. Barriers Vendor lock-in, Security of cloud, services and Data, privacy, Dependence on internet, Cost of bandwidth [7].

In the context of cloud computing, risks associated with underlying technologies, risks involving service models and outsourcing, and enterprise readiness have been recognized as potential barriers for the adoption. To accelerate cloud adoption, the concrete barriers negatively influencing the adoption decision need to be identified. The research aimed to understand the impact of technical and security-related barriers on the organizational decision to adopt the cloud. The study underlines the importance of the technical and security perspectives for research investigating the adoption of technology which were as following: Technical: IT infrastructure complexity, Integration challenge, Vendor lock-in, Reliability and performance. Security: General security concerns, Data privacy, Data loss, Lack of trust. Financial: No budget for new initiatives, High implementation cost, Difficulty to evaluate benefits. Legal & Organizational: Legal jurisdiction, Enterprise compliance, insufficient knowledge, No suitable solution, Viability of third-party vendor [8].

5. Identification of barriers of cloud manufacturing

Finally, the barriers of the cloud manufacturing collected through the literature review for the further analysis and a useful interpretation stated in Table 1.

S. No.	Barrier	S. No.	Sub Barriers	References
1	Technological/ Technical	1	IT Infrastructure complexity	Expert opinion
		2	Vendor lock-in	Attaran et al(1996)
		3	Reliability and performance	Expert opinion
2	Protection/Security	4	Data privacy and loss	Expert opinion
		5	Lack of trust	Attaran et al(1996)
3	Internet of Things/Broadband availability	6	Lack of capturing and sharing of knowledge on net	Expert opinion
		7	Dependence on internet	Expert opinion
		8	Bandwidth	Expert opinion
4	Cost/Finance/high bandwidth costs	9	Budget for new initiatives	Nagar and Raj (2013)
		10	High implementation cost	Attaran et al (1996), Nagar and Raj (2013)
		11	Difficulty to evaluate benefits	Nagar and Raj (2013)
		12	Suitable solution	Nagar and Raj (2013)
		13	Viability of third-party vendor	Nagar and Raj (2013)
5	Effectual /	14	Legal jurisdiction	Expert opinion

	Legal/lack of awareness and expertise	15	Enterprise compliance	Mittal & Sangwan (2014)
		16	Insufficient knowledge	Attaran et al(1996), Mittal & Sangwan (2014)
6	Organizing for cloud	17	Cloud not a daily focus	Attaran et al(1996), Hicks & Matthews (2010), Mittal & Sangwan (2014)
		18	Roles and responsibilities not defined	Attaran et al(1996), Hicks & Matthews (2010), Mittal & Sangwan (2014).
		19	Lack of involvement	Attaran et al (1996), Hicks & Matthews (2010), Mittal & Sangwan (2014)
		20	Lack of teamwork	Attaran et al(1996), Hicks & Matthews (2010), Mittal & Sangwan (2014)
		21	Ignorance regarding the many new possibilities with modern e-Business.	Attaran et al(1996), Hicks & Matthews (2010), Mittal & Sangwan (2014)

6. Concluding Remarks and scope for future work

This paper presents a new service-oriented manufacturing paradigm – cloud manufacturing. In this paper, a series of issues on Cloud Manufacturing are investigated, including the background, concept, architecture and typical characteristics of Cloud Manufacturing, the key technologies for implementing Cloud Manufacturing and the construction of manufacturing cloud. The studies and applications of Cloud Manufacturing technologies will further improve the 'networking, intelligent, and service' of manufacturing and then promote the manufacturing information to a new level.

The work may be extended by analysing these barriers using interpretive structural modelling and Structural Equation modelling techniques.

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