Critical Factors for Successful User-Supplier Integration in the Production System Design Process

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Abstract. Integration of equipment suppliers in the design of the production system has often been associated with major benefits. However, from a managerial perspective, integration between the user and the suppliers of the production equipment is still challenging. Therefore, the purpose of the research is to explore how manufacturing companies can facilitate and manage equipment supplier integration when designing the production system. Based on an real time case study in the automotive industry 10 critical factors for successful supplier/user integration are identified, which can be classified into three categories: human factors, project management factors and design factors.

Keywords. Production system, manufacturing industry, equipment supplier, integration

1 Introduction

For manufacturing companies active on the global market, high-performance production systems that contribute to the growth and competitiveness of the company are essential. Among a wide range of industries it is increasingly acknowledged that superior production system capabilities are crucial for competitive success. However, today's focus is on the operations phase, i.e. the serial production of products, rather than on the previous design of the production system. As a result, production systems are generally designed relatively shortly before their installation [1]. That is also the reason why implementation of lean production in manufacturing industry is largely directed towards improving the operational performance of the production system. This is today true for the global manufacturing industry worldwide. Lean production is the combined set of philosophy, principles and tools for managing their production systems. In the end of the day, however, the real root-cause for many problems and losses in production ends-up with issues that emanate from the design process of either the product or the corresponding production system [2].

The potential of gaining a competitive edge by improving the way the production system is designed is hence ignored, although it is a well-known fact that the production system design process is the foundation for achieving a high-performance production system [3]. Consequently, if the production system is not designed in a proper way, this will eventually end up with disturbances during both start-up and serial production. The result is evidently low capacity utilization, high production cost and hence low profitability as well as a high environmental impact.

When the process of designing the production system is recognized in industry as a means of achieving the best possible production system, the next step for industry is to actually utilize this design process for innovation and differentiation by the creation of new production processes and technology that supports the need for increased sustainability. Since the technical subsystem of the production system is often designed and built by production equipment suppliers rather than made in-house by the manufacturing company [4], it is critical to successful integrate equipment suppliers when designing the production system. The purpose of this paper is to identify and discuss critical factors facilitating an integrated user-supplier approach when designing production systems working as a means for the creation of better and more sustainable solutions.

2 Frame of reference

2.1 User-supplier integration characteristics

The process of designing a production system can be divided into several distinct phases comprising all necessary activities from the analysis to the detailed design of the selected system solution [2]. The ASE model identifies (problem) analysis, (solution) synthesis and (solution) evaluation as the general activities in an engineering design process, which can be transferred to the specification of requirements, generation of concepts and evaluation of concepts when designing the production system [5]. As a result, integration between the user (the manufacturing company) and the supplier (of machines and production equipment) is required in the different activities in each phase of the production system design process, see Figure 1. Although the different phases in the design process are visualized sequentially here, it is important to emphasize that the design process should be considered as an iterative, cyclic process affected in its execution by each project context.

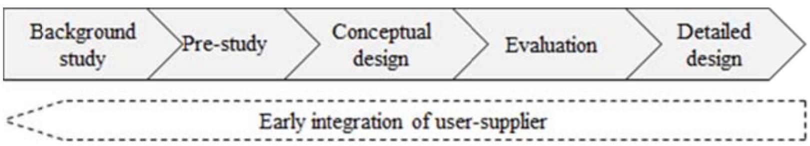

Fig. 1. The integration of users and suppliers in the design of the production system [modified from 2]

Despite the potential, from a project management perspective, an integrated user-supplier design approach is still challenging. Integrated design work can be considered as a type of open innovation. Henry Chesbrough defines open innovation as “the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation, respectively” [6, p. 1] and the implication of this definition is that companies could and should use both internal and external knowledge, ideas and paths to market, when they seek to maximize returns from the development activities. The study of Enkel et al. [7] shows, that loss of knowledge, higher coordination costs and loss of control and higher complexity are mentioned as frequent risks connected to open innovation activities. Thus, by working together with an equipment supplier, a manufacturing company faces the risk that knowledge about core production processes is transferred to competitors via the equipment suppliers [8]. As such, it is useful to review critical factors for successful user-supplier integration when designing the production system.

2.2 Critical factors

Yin and Ning [9] developed a framework suggesting that an inter-enterprise information system, a partnering relationship among the participating organizations and an integrated dynamic planning process are critical factors. Focusing on the collaboration between equipment suppliers and users Rönneberg Sjödin et al. [10] argue that more resources should be spent in the early phases as it is important to facilitate intensive collaboration with equipment suppliers. Otherwise, mechanisms important for integration such as meetings, workshops, and teambuilding are limited, which may result in strained relationships, which cannot be recovered at later stages.

Another factor important to consider is an adequate management of information flow between the equipment supplier and the user [11]. In order to realize the benefits of collaboration with an equipment supplier, it is important that the exchanged information is cautiously tailored to the specific needs of the partner. Organizing the collaboration in a formal process and appointing a skilled contact person supports an effective flow of information [11].

Further, even in situations where the equipment supplier has a major role in the design of the production equipment, it seems necessary to maintain certain competencies also within the manufacturing company. Hobday *et al.* [12] point out that the trend towards outsourcing has made it even more essential to keep in mind the required in-house competences for system integration. Von Haartman and Bengtsson [13] conclude that to be able to benefit from supplier integration, manufacturing companies have to possess corresponding in-house competences.

When integrating the supplier in the design work, an appropriate use and understanding of contracts and governance mechanisms is important. Lager and Frishammer [8] emphasize the need to consider the “nature” dimensions (proprietary/non-proprietary) in order to avoid the unintentional diffusion of important in-house know-how to competitors. Incentives, authority and trust are important tools to govern complex procurement situations involving several actors [14].

3 Research Methodology

The research is founded on one real time case study at a Swedish manufacturing company, which gives the possibility of being close to the data, thus enabling a close-up view on patterns, and how they evolve [15]. In line with previous production system design research, our view is that the case study provided a good possibility to capture a more complete and contextual assessment of the process of integrating equipment suppliers in the design work. Clearly, applying a single case study approach suffers from problems of generalization [16]. However, the single case study results created here do not rely on statistical generalization but on analytical generalization, i.e. generalization towards theory, which is a potential provided by the case study methodology.

The study was part of a new product development project, which required the design of a new production system since the new product could not be assembled at the existing production line but required the design and building of new production equipment. The unit of analysis was the production equipment acquisition project at the manufacturing company in which the equipment supplier played a key role in the design and building of the production equipment.

Data was collected between November 2009 and August 2011, where actions and events were observed in real time for 37 days. Overall, being at the company was important for the data collected. For example, on several occasions, project members discussed critical aspects and possible problem solutions at greater length during the lunch break than in project meetings. Data were collected from multiple sources of evidence including passive and active observation, semi-structured interviews and documents aiming at data triangulation. In practice, the same problem or fact was addressed by more than a single source of evidence during the data collection.

The collected data has been analysed according to the guidelines provided by Miles and Huberman [17], i.e. data reduction, data display and conclusion drawing/verification. In order to reduce and display the data in an appropriate way, directly after each time of data collection the findings were summarised and transferred into a worksheet for further analysis. Further, a detailed description of the case was developed. The results from the case study were compared with and related to the existing theory, i.e. enfolding the literature.

4 Empirical findings

The background to the project studied was the need to replace the existing assembly system as a consequence of the design of a new product generation. The idea generation and concept iteration for the production system was carried out under severe time pressure as the time plan for product design was not adhered to and the resources allocated were inadequate at the beginning while the date for start of production was unchangeable. At the manufacturing company, most of the internal work regarding the design of the production equipment was carried out by the production engineering department and the project leader responsible for the industrialization, i.e. the process required when transferring the product design into start of production. The selected equipment supplier was located in Sweden but in another city about 500 km away. The equipment supplier had wide experience as project supplier to the automotive industry and was thus aware of the particular requirements of the automotive industry. Since there was little room for concept iterations, the case study company commissioned one equipment supplier to design a concept solution between November and December 2009. In parallel, two internal solutions were created based on the earlier ideas of the production engineering manager. The three different concepts were evaluated and synthesized into one final solution, including solutions for production equipment and material supply aspects.

The design of the production equipment followed a formalized process in which the case study company had mapped out different steps or activities that the equipment suppliers had to complete at various points in the process. The activities undertaken in each stage incorporated the transfer of new information from both sides. Since the company normally involves equipment suppliers a considerable amount of standards and rules were used such as the technical requirement specification. However, also new standard documents were created. For example, the manufacturing company put a lot of effort on collecting and documenting more project specific requirements.

To coordinate the work between the user, i.e. the case study company, and the equipment supplier, a time plan was created. The time plan included not only key dates to be kept in the project such as when the factory acceptance test or site acceptance test should be carried out but also several verification occasions, which should take place under the project progress. The verification occasions were summarized in a verification plan, which was used to outline when and how the fulfillment of the specified requirements and the progress of the design and development of the production equipment should be followed up and assessed. In addition, the equipment suppliers and the manufacturing company appointed contact persons. The contact person appointed by the manufacturing company was a production engineering manager who had experience from previous development projects and was also the system designer of the assembly line used for the previous product generation.

Further, during the production equipment acquisition project a number of meetings comprising different participants from the user and supplier company took place. Depending on the purpose of the meetings, employees from different functions with different knowledge were invited. For example, assembly operators attended the discussion about the screen size at each workstation, while employees from the information technology department contributed to the decision about the operating system. The meetings at the manufacturing company offered an opportunity for the equipment supplier to study the manufacturing plant and the assembly of the actual product, to collect information about on-going manufacturing and the production processes connected to the targeted production system part, i.e. the equipment to be built.

5 Critical factors for successful integration

The potential of integrating equipment suppliers in the production system design process are compelling. In the studied project, the integration of the equipment supplier resulted into an innovative and new solution based on the access to and application of new technology. Although the potential benefits can be substantial, integrating equipment suppliers in the production system design process is sometimes an uncomfortable way of doing business. In order to achieve successful integration and thus better production systems a total of 10 critical factors were identified, see Table 1. This factors help to identify reduce potential barriers and expand the relationships between the partners.

Table 1. Critical factors for improved user-supplier integration in order to accomplish better production system solutions

Factor	How it contributes to user-supplier integration
Human factors	
Appoint skilled contact person	The contact person enables easily access to missing information and is also used to discuss critical issues.
Assign suitable resources	Resources needs to be available to engage in the design process and thus to make integration possible.
Build trust	The manufacturing company needs to have confidence in the equipment supplier's capabilities.
Core team	A cross-functional team ensures a holistic perspective and speeds up the decision making. Clear and explicit goals should be established.
Project management factors	
Contract	Regulatory issues are clearly defined and help to minimized concerns that either part will take advantage.
Formal approaches	Formal methods such as the process applied, documentation and planning facilitates coordination and synchronization of work activities.
Frequent face to face meetings	Meetings are used to reduce any equivocality surrounding the process of designing the production system and help to align the culture of the two partners.
Information flow	Open communication channels are required to improve decision making and ensure that all partners are updated.
Design factors	
Joined idea generation	Joined idea generation contributes to clear directions and expectations for the project. The creativity of all individuals involved can be utilized in both concept and detailed design. Further, each partner can identify possible benefits.
Specified requirements	Specifying as well as understanding requirements of the user contributes to a solution in line with the needs.

The findings highlighted the importance of the humans involved in the design process from both partners, i.e. the equipment supplier and the manufacturing company. The results of the case study indicate that it is particularly important to have a skilled contact person at the manufacturing company, which is in line with earlier research [12, 13]. This person can be compared to the role of a gatekeeper in new product development projects, i.e. a person which can overcome barriers based on differences such as terminology, norms, and values [18]. The contact person can be considered as a key communicator between both organizations and provide a link between the manufacturing company and the equipment supplier. To have the right competence at the manufacturing company is important to evaluate and judge the appropriateness of the solutions proposed by the equipment supplier.

Further, the empirical findings show that the project management is critical for successful user-supplier integration [1]. The coordination between the equipment supplier and the manufacturing company are likely to benefit from a formal approach [11]. Following this recommendation leads to different initiatives may be established. Effort should be placed on planning activities and establishing a standardized process and documents. The reason for not being able to coordinate the work of the two partners and being late is because the underlying means used are not constructed to support the work at physical dispersed settings. On the other hand by applying for example a structured process gives advices on what work activities needed to be completed at different points in time and what decisions that needed to be accomplished at different points in time. In addition, the findings indicate that in line with prior research [e.g. 10] efforts should also be placed on communicating the expected production system solution internally, i.e. within the own (user) organisation including product designers and the end-user such as operators, and support functions like production engineers or maintenance engineers. Thus, face-to-face meetings could be used to invite also other people outside the core team. By involving end-users as early as possible in the process their input and feedback could be considered when designing the production system thus avoiding late design changes.

Often equipment suppliers are involved when the manufacturing company has already developed its scope of supply including a conceptual solution and the requirement specification. However, the potential benefits that can be achieved by integrating the equipment supplier in the design process are minimised if the equipment supplier is included at this late stage. Thus, there is a need to include equipment suppliers earlier, while at the same time negative effects such as the risk that key competences are distributed to competitors should be minimised. This means that there is a need to look at intellectual factors focusing on achieving a good balance between competition and co-operation. Hence, technical aspects of the buying process need to be addressed [8, 14].

6 Conclusions

The purpose of the paper was to identify and discuss critical factors facilitating an integrated user-supplier approach when designing production systems. From the rich database of the real-time case study, a total of 10 critical factors were identified, which in one way or another have an impact on integration between user and supplier. Underlying these factors were three categories: humans, project management and design factors. The three factors are thus related to existing theory. However, what we add is a description of the specific details of user-supplier integration when designing the production system, an issue which has only been addressed to a limited extent.

The research presented in this paper should be seen as a first step to improve the integration between users and suppliers in the design of the production system and clearly more research is needed. For example, our empirical findings revealed somewhat unexpectedly that despite physical distance and organizational boundaries, there were no major coordination problems between the partners. Thus, gaining a better understanding of the barriers for supplier-user integration in the design of the production system is needed to be able to identify ways to overcome them to achieve the creation of better and more sustainable solutions.

References

1. Bruch, J.: Management of Design Information in the Production System Design Process. PhD thesis, Mälardalen University, Eskilstuna (2012).
2. Bellgran, M. and K. Säfsten: Production Development: Design and Operation of Production Systems, Springer-Verlag, London, UK (2010).
3. Slack, N., et al.: Operations Management. 2nd ed, Pitman, London, UK (1998).
4. Reichstein, T. and A. Salter: Investigating the sources of process innovation among UK manufacturing firms. Industrial and Corporate Change. Vol. 15, No. 4, 653-682 (2006).
5. Wiktorsson, M.: Consideration of Legacy Structures enabling a Double Helix Development of Production Systems and Products. In: Submitted to Springer book on Technology and Manufacturing Process Selection: the Product Life Cycle Perspective. pp. (2012).
6. Chesbrough, H.: Open innovation: Researching a New Paradigm for Understanding Industrial Innovation. In: Chesbrough, H., Vanhaverbeke, W., and West, J. (eds.) Open innovation: Researching a New Paradigm. pp. 1-12. Oxford University Press, Oxford (2006).
7. Enkel, E., O. Gassmann, and H. Chesbrough: Open R&D and open innovation: exploring the phenomenon. R&D Management. Vol. 39, No. 4, 311-316 (2009).
8. Lager, T. and J. Frishammar: Equipment supplier/user collaboration in the process industries: In search of enhanced operating performance. Journal of Manufacturing Technology Management. Vol. 21, No. 6, 698-720 (2010).
9. Yeo, K. and J. Ning: Managing uncertainty in major equipment procurement in engineering projects. European Journal of Operational Research. Vol. 171, No. 1, 123-134 (2006).
10. Rönnberg Sjödin, D., P.E. Eriksson, and J. Frishammar: Open innovation in process industries: a lifecycle perspective on development of process equipment. International Journal of Technology Management Vol. 56, No. 2-4, 225-240 (2011).
11. Bruch, J. and M. Bellgran: Design information for efficient equipment supplier/buyer integration. Journal of Manufacturing Technology Management. Vol. 23, No. 4 (2012).
12. Hobday, M., A. Prencipe, and A. Davies: Introduction. In: Prencipe, A., Davies, A., and Hobday, M. (eds.) The Business of Systems Integration. pp. 1-14. Oxford University Press, New York, NY (2005).
13. Von Haartman, R. and L. Bengtsson: Manufacturing competence: a key to successful supplier integration. International Journal of Manufacturing Technology and Management. Vol. 16, No. 3, 283-299 (2009).
14. Olsen, B.E., et al.: Governance of complex procurements in the oil and gas industry. Journal of Purchasing and Supply management. Vol. 11, No. 1, 1-13 (2005).
15. Leonard-Barton, D.: A Dual Methodology for Case Studies: Synergistic Use of a Longitudinal Single Site with Replicated Multiple Sites. Organization Science. Vol. 1, No. 3, 248-266 (1990).
16. Yin, R.K.: Case Study Research: Design and Methods. 4th ed, SAGE, Thousand Oaks, CA (2009).
17. Miles, M.B. and A.M. Huberman: Qualitative Data Analysis: An Expanded Sourcebook. 2nd ed, SAGE, London, UK (1994).
18. Tushman, M.L. and R. Katz: External Communication and Project Performance: An Investigation into the Role of Gatekeepers. Management Science. Vol. 26, No. 11, 1071-1085 (1980).