Creating Strategies to Improve the Use of IT- and IS-Systems in Final Assembly

Åsa FAST-BERGLUND, Dan LI and Magnus ÅKERMAN
Chalmers University of Technology, SE-412 96

Abstract. Assembly systems are complex due to mass customization. In order to be able to produce a variance of products a well functional information system is vital. Companies need a digital strategy in order to design adaptive systems to increase flexibility and usage of information support systems (IS-systems) among operators. In case studies from Swedish industries, it is shown that operators often use their own experience when assembling products. This paper aims to describe how a digital strategy can be developed, combining IT-systems and IS-system to create dynamic systems for operators. The paper will combine two methods, MEET-model that has been used to improve meeting situations but could also be used to create digital strategies at companies. An additional use of the Delone and McLean model will be used to create the bridge between the IT-system and the IS-system. Results show that combining these models gives a clearer and broader view of the digital strategy and a possible bridge between IT- and IS-developers to create a better and more dynamic shop-floor IT system.

Keywords. Delone and McLean model, Shop floor IT, Industry 4.0

1. Introduction

In order to create a well functional and well-used support system for assembly operators, an understanding of the relation between the Information Technology (IT) and Information Support (IS) system is vital. Many different models have been developed for IT/IS (Rockart, Earl, & Ross, 1996; Shannon & Weaver, 1949) but not directly fitting the shop-floor of manufacturing. Information systems strategy (ISS) was emerging in the 70s and defined as ‘activities directed toward (1) recognising organisational opportunities for using information technology, (2) determining the resource requirements to exploit these opportunities, (3) and developing strategies and action plans for realising these opportunities and for meeting the resource needs’ [1]. The fourth evolution in the manufacturing increases the number of technologies used which also increases different information systems on the shop-floor. New technologies for future smart industries require an information system design that supports both technical communication and human decision-making. This puts demands on interoperability between systems but also between humans. Interoperability is the characteristic due to which, system units would be able to exchange and share information with each other. In order to combine humans and machines and to create...

The information support system is a vital part of the assembly system and provide assembly operators with appropriate information that allows products to be assembled in the right time and with the quality, thus reducing the perceived complexity for assembly operators [5]. Designing such information systems is difficult, often it is personal meetings, excel sheets or printed papers that are used as IS-system [6]. The belief that more data or information automatically leads to better decisions is probably one of the most unfortunate mistakes of the information society [7]. Relevance, timeliness, and accuracy of information are still key to information quality [8] and has been for over sixty years. When implementing shop-floor IT, there is no real measure of success, no KPIs for how well the IT-system work. For the production system measures of success have always existed i.e. KPIs to understand how [9]. A measurement gap seen in the industry is how to measure the success of implementing an information system so that shop-floor IT could be followed and improved in the same matter as the production system. The lack of accurate quantitative measures for the output and value created by information technology has made the manufacturing IS manager’s job of evaluating investments particularly difficult [10]. Ten years later Oz tried to define IS measures in production, and his conclusion was that corporate boards of directors have long given up expecting a detailed return on investment calculation for investment in IT [10].

This paper will explore how the strategies for shop-floor IT and shop-floor IS can be designed and measured in order to create a combined effective and well-used system i.e. adoptable interoperability of systems.

2. The DeLone & McLean model

In order to create a strategy for shop floor IT-IS systems, the Delone and McLean model has been used to collect KPIs or areas to measure to be able to design a successful system. DeLone and McLean have, for over twenty years, tried to define a way of measuring IS and IT success [11]. The D&M model of measuring IS success has been used in many different areas but few of the studies measured the success of implementing a good IT and IS support for assembly operators, production preparation and global strategies for assembly instructions. An ontology describing the relationships between these areas by using success parameters could be a way to start building adoptive interoperable knowledge system for operator 4.0 [12]. The success or failure of organizations use IT, however, is only partially dependent on the effectiveness of the IT-organization. It is even more dependent on the capability of line managers at all levels to understand the capabilities of the IT resource and to use it effectively [13]. Earl (1989) proposes that IT strategy and infrastructure should be aligned with information systems strategy (i.e., the applications and information) within an organization. This is associated with the effectiveness of the system while the digitalization strategy is more how the IT-IS system influences the user and the success of the system [14]. A taxonomy with different relations to measure the success of an IS was developed 1992. This taxonomy consists of nine [15] different dimensions. The nine dimensions could be divided into IT/IS- subsystems illustrated in Figure 1.
There are two different impacts using a smart information system, organisational impact and individual impact.

The organisational impact is closely connected to the IT-system and strategic decisions on what to use. The business strategy could affect what technology to use and how to use it, i.e. a strategic fit and functional integration [16]. There could be a push to use a different technology based on a strategic organizational decision that gives the operator no choice but to use that solution [17, 18].

The Individual impact is closely related to the IS-system. Case studies in Swedish industry show that about 23 percent of operators use supporting information when assembling [19]. If one operator feels that they have the impact to design and choose how, what and when to get the information the belief is that the implementation success increases. Earlier studies have shown that it is a little more complex than that, even if the individual impact (R²=0.557) and user satisfaction are moderately high and the user satisfaction (R²=0.607) is high, the intention to use the instructions was low (R²=0.272) which could indicate that the instructions are not used [20].

System quality and Service quality are both closely connected to interoperability of the IT-system. Interoperability covers every aspect of communication from technical aspects, via semantic issues, up to organizational impact [21]. Therefore, it is an important concept that should not be overlooked when designing and interconnecting new systems with human users. Interoperability “is the ability for two systems to understand one another and use the functionality of one another” [22]. Interoperability is often divided into four levels: technical, syntactical, semantic, and organisational [23] where the technical and the syntactical is connected to system quality and the semantic and organisational is connected to the service quality. Technical interoperability is the hardware/software aspects of systems connectivity. Syntactic interoperability concerns how data is transferred, usually managed by standardised communication protocols. Syntactic interoperability concerns how data is transferred, usually managed by standardised communication protocols. At the semantic level, the
data is used according to agreed-upon definitions and includes both humans and other systems. Organisational interoperability measures how well entire organisations can exchange data and information [23]. Both the system and service quality is dependent on the four design principles on which Industry 4.0 systems are based: interconnection, information transparency, decentralised decisions, and technical assistance [24]. The interconnection principle is the most fundamental requirement. It means that machines, devices, sensors, and people need to be connected to enable communication and collaboration. Information transparency means to collect data from the virtual and the physical world and combine it into context-aware information, and this contributes to the information quality in the IS-System. Decentralised decisions are important to reduce the complexity of the many different autonomous decision makers involved. Hence, it is important to not have two systems at the same time handling the same data, which increases the risk for redundancy of information and thereby also increases the mistrust among operators and misuse or disuse of the IS [25]. Finally, technical assistance for human workers becomes more important in an Industry 4.0 environment because of the increased complexity and the change towards more strategic tasks, if this works well in the systems it creates a positively perceived information quality.

**Information quality** is also related to the IT-system in terms of the carrier and content of information. This is the front-end of the IT-system e.g. the things that the operator sees. To achieve efficiency and proactivity for the operator and to increase the perceived information quality six qualitative criteria needs to be fulfilled [26] i.e.

1. Relevance - Users benefit in their decision or action because of it;
2. Timeliness - Information is available in time;
3. Accuracy - Information is free from error;
4. Accessibility - Information is readily available;
5. Comprehensiveness - Information is free from omissions and redundant data;
6. Format - Effectiveness with which information is perceived.

Today there are a lot of new technologies available such as wearables, VR and AR. It is important to know what to use the information carrier for, in what phase and whom to use it [27, 28].

The perceived information quality is closely related to create user satisfaction and to provide solutions to increase the use of the instructions.

**User satisfaction** The impact of a User-developed application (UDA) on an individual’s work performance increases as intended use increases, further the impact of a UDA on an individual’s work performance increases as user satisfaction increases [20]. This means the personal involvement designing the IS-system increases the user satisfaction of the user.

**Intention to use** Automation is often designed with a focus on technology rather than how the new system will change the task for the operator [25]. To the contrary, this paper has shown a solution based on the assembly personnel’s needs. If the benefit offered from automation is not apparent to the operator there is a risk that it will be unused [25]. Furthermore, line leadership is an absolute necessity for the effective implementation of information technology since the leaders are close enough to their business segments to see the most effective ways to utilize this resource [13].

Success parameters; Attitudes toward technology, Subjective norms, Self-Efficacy, Trust, Technology experience, Enjoyment.

**Use**; In Swedish industry, approximately 75 percent of the assembly operators use their own experience when assembling products [19]. A Technology Acceptance Model (TAM) [29] could be used in order to measure the use of technologies, other parameters
used in the D&M model are; Task compatibility, Extrinsic motivation, Organisation competence, Self-Efficiency, IT infrastructure, Management support.

3. Conclusion

To be able to create a strategy for IT-IS systems in final assembly, measurable parameters i.e. KPIs needs to be collected and analysed. This paper has shown nine focus areas where it is important that KPIs are collected. The author believes, in line with Boynton and Zmund [1], that the company needs to recognize the opportunity for using information technology, and this sometimes means a push towards use. Furthermore, to determine the requirements from the operators to exploit the opportunities; this is connected to the perceived quality of the information system, the intention to use and the individual impact. Lastly, to develop action plans to meet the organization and the individual impact of using the IT-IS systems.

Acknowledgements

The author wants to thank Vinnova and FFI for supporting this research in the project GAIS 2.

References