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Interorganizational learning in manufacturing networks

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Abstract. The ability to acquire and utilize new knowledge within an inter-organizational context is considered a key factor for gaining competitive advantage. This study aims at investigating how organizations do cross-border collaboration in the context of realizing Industry 4.0 principles at the operational level. The ever demand for advances in products, processes and systems, in a symbioses of product- and service performance, require new skills and knowledge at both organizational and inter-organizational level. This study investigates three case companies, and their maintenance departments, in order to understand if and how their role has changed in parallel with the adaption and implementation of Industry 4.0.

Keywords: Interorganizational Learning, Case Study, Industry 4.0.

1 Introduction

Industry 4.0 is an area that has received great interest in the last decade, especially among scholars and scientists. The opportunities that industry 4.0 can bring for industries are seemed to be of great value in terms of efficiency based on improved decision support systems at the machine-human interface, HES, connectivity throughout the value chain, and maintenance operations [1]. Industry 4.0 is predicted to significant impact product life cycles and product value chains, where increased digitization, automation and connectivity among companies in complex and comprehensive value chains will change the existing industrial collaboration platforms and how they operate and function. Additionally, it is anticipated that industries will become more flexible and effective in resource allocation. Traditionally, clusters are considered as a number of firms that share some key characteristics, and they may compete with each other where rivalry and competitiveness can be an important driver for innovation. Because of somewhat similarities in production capabilities performance benchmarking can enhance increased efficiency and competitiveness across the cluster as a whole [2]. However, globalization, product diversity, shorter product life cycles, and sustainable measures increase complexity beyond traditional geographical and/or complementary clusters [3].

The nature of networks and value chains is contextual according to type of market and industry. There can be dispersed and complex value chains, requiring many actors and processing steps, to manufacture the final product to global markets, and smaller and more local entities to serve market areas. Number of organizational interactions in combination with level of innovation according to product, process and system

accumulates uncertainty. Thus, complexity in terms of unknowns and interdependent, non-linear factors that cannot be solved by existing methods, rules, systems and processes has to be managed [4].

In organizational learning, the word *inter* is adding a new dimension to learning. Interorganizational relations are "relatively enduring transactions, flows, and linkages that occur among or between an organization and one or more organizations in its environment" [5]. This concept sheds new light on how knowledge and learning are located not only inside organizations, but also outside, where organizations are being part of a larger network of both social and material relationship. This sort of relations are set to cross organizational boundaries [6]. Despite different designation on the term interorganizational learning and its meaning, such as joint learning, horizontal learning, shared learning, relationship learning, network learning, they are applicable to project how learning and knowledge creation may form in value chains and networks. Selnes and Sallis [7] defines relationship learning as: "*a joint activity between a supplier and a customer in which the two parties share information, which is then jointly interpreted and integrated into shared relationship-domain specific memory that changes the range or likelihood of potential relationship-domain-specific behavior*". Another view of interorganizational network is that these networks are created in order to share some sort of knowledge, and that an alliance of learning for developing dynamic capabilities is formed in which some will be learners and some will be teachers [8].

Developing abilities to adapt methods and operations according to the changes that happens in company surroundings is considered an important asset for companies [9]. In relationship learning, there are three sub-processes included; Information sharing, joint sense-making, and knowledge integration. Information sharing may act as the fundament for relationship learning [7]. It is discovered that information sharing is central for work-relationships to function, and that information must be exchanged to make coordination and planning possible. This is believed to ultimately make operational efficiency possible. Secondly, it is believed that dialogue and communication is a key factor for common interpretation and sense-making among the participants in the relationship. This is especially important when considering how different organizations can be, and that there exist clear differences on how new information are being interpreted and made sense of.

This paper addresses the following research question: How can interorganizational learning enhance Industry 4.0 realization and operational effectiveness?

2 Method

A qualitative research approach is typically used to discover new insights on a topic or area where there is little information available. Some possible advantages of conducting a qualitative research is that one can reveal new insights in areas that have received relatively little research, and it can help understand complexities, situations, processes, relationships, systems or people. In qualitative research it is easier to test the validity of certain assumptions, claims, theories, or generalizations in a real-world context, and it can help bring forward new information to verify, develop and improve

concepts or theories on a phenomenon. For instance the theory of informal collaboration in geographical clusters [10] is an assumption to be tested by the proposed method. Within a certain area, qualitative research can help reveal obstacles and problems that may exist, as well as giving the opportunity to evaluate the effectivity of certain practices [11]. To help answer the research question in this study, there have been conducted semi-structured interviews of operators and managers in three different case companies within a defined industrial cluster. The organizational level of interest is the maintenance department. This selection is made by hypothesizing that maintenance departments are central in the transition towards an Industry 4.0 state. All three organizations are well established manufacturing companies in the medium size segment, mainly exporting goods and product out of Norway.

The data gathering aimed at receiving insight and information within the defined topic and scope of this study from a practical real-world perspective. The interview guide was constructed in way that it should be executed in the same fashion for all respondents, letting the interviewee describe, explain and share their thoughts, knowledge and understanding, based on their own interpretations and views on the field of study was an important part of the research. By asking open questions and allow for individual interpretation and understanding to be highly evident, there was believed that new, interesting and objective data could be revealed. Despite having a structured, or semi-structured interview guide prepared, the interviews tended to be conversation about their practices, understanding and insight on the topic, which is often desired in such scenarios. The companies, respondents and their answers will be kept anonymous and neutral in this article.

The interview guide consists of the three parts: introduction, key-questions and additional questions. The main part, key questions, is supported by 15 questions, where the objective is asked about frequency of interaction, type of interaction, importance of interaction, relevance of interaction, roles (and equality) in interaction, content and scope for interaction, barriers/enablers in interaction, how knowledge is developed, shared and integrated, evolution of interaction and your role in influencing knowledge networks.

Critics to this method and approach is that the sample size is small and not necessarily representative of the broader population. Thus, generalization is difficult – and it is difficult to tell how far the findings are biased by the researcher's own opinions and the way the interviews where conducted.

3 Results

3.1 Case A

Results from the interviews at case company A demonstrates low degree of inter-organizational learning, at least in an organized and formal manner. In the maintenance and manufacturing departments, there are considered to be a low degree of interaction with other maintenance departments across the industrial cluster. But there exists informal interaction in terms of informal meetings between workers that have some sort of

personal relations with other workers in the cluster. These connections stem from the fact that people in the past has been colleagues in the same company or that they are sharing hobbies and/or neighborhood. There are considered to exist some sort of exchange in experience and knowledge at this level, but because of the degree of informality it is categorized as transfer of tacit knowledge. The workers confirm that they do seek other industries to gain new insight and to understand how other practices unfold due to change in technology. Their supplier base is also reported as a valuable source of information, where frequent, planned or un-planned meetings with suppliers due to particular issues or fixed service schedules increase the bandwidth to externals. The interviewee points out that being a part of regional industrial cluster has been a decisive factor for their ability to develop and grow the business in recent years. Access to local competence, personnel, personnel rotation, and equipment are just a few decisive contributions for this development. The department also reports that they in the future will work more pro-actively towards the outside world, particularly in making spare parts available for others through open digital systems.

3.2 Case B

The same tendency seems to apply to case company B, where little organized interaction with other companies and maintenance departments, inside and outside the industrial cluster, is reported. The limited number of relations that exist between the companies is said to be an important factor for the limitations in communication. They claim that relationships were stronger before, but now diluted because of the changed nature of the cluster in terms of number of companies, core products and changes in the resource pool of the different companies. The cluster has evolved from one relatively big cornerstone company towards more than 40 separate companies targeting different segments and markets. This journey has taken 20-30 years, so ties and bonds exist between those employees that has been part of the described transition. There is reported no formal structure for interacting with other firms, and the perceived busy work mode leaves little room for interacting with others. The highest ranked type of outside interaction is with their suppliers. High degree of learning and knowledge-creation is reported to happen at the intersections with their existing suppliers of core technology for manufacturing of their products. Case company B asserts that they are continuously leveraging their technology, and they make regular investments and replacements to improve their maintenance performance. Investments in robots, control systems, machinery and equipment are about many technological investments that are made recently. Frequent interaction and communication with suppliers are central in this technological evolution. This source of information guides decisions with regards to Industry 4.0 based on insights and common understanding on how new technology can improve manufacturing capability. Supplier meetings are regarded as learning sessions, where as many as possible of the maintenance workers are involved to create a common understanding and baseline for further learning.

3.3 Case C

Case company C reports in general that learning processes are internally focused due to the long term systematic continuous improvement program going on. Improving existing capacities and capabilities have been the focal point for some time, impacting how internal knowledge creation, sharing and realization is organized through lean-principles. The reasoning by this operational strategy is reported to be rooted in a combined need for cost-cutting as well as producing at high capacity utilization. Perceived daily intensity to maintain and operate critical equipment for producing the demanded quantity is said to limit communication with other organizations. High utilization of human and technological capabilities is argued to reduce their ability to engage in learning activities related to new technologies possible available in the cluster and value chain. This "constant" situation makes interorganizational learning unpractically and difficult. Competing from a defined high-cost country, and numerous lean programs, leaves no free capacity to educational activities or learning from neighboring companies. The growing dynamic of the industrial cluster is also said to be a barrier for inter-organizational level, because it requires a lot of effort to keep updated on what the others do. Some years ago, there were closer bonds between the firms, and the interpersonal connections were more frequent. This led to a situation where the threshold for interacting outside the firm was lower, and it was also in some cases more necessary and practically needed, because the industrial cluster was more homogenous. Despite the lack of organized inter-organizational learning, there are to some extent reported interaction and learning from the supplier base. Especially new investments and implementation of new technologies spur curiosity and knowledge creation and sharing within the company as well as between the company and the particular suppliers. Case C is also part of large international company, getting impulses from sister plants in the global production network.

4 Discussion and conclusion

Learning and knowledge creation is considered as a difficult and fuzzy domain, hard to express, measure and manage. This is often the situation at organizational level, so how can we approach it from an inter-organizational learning perspective. It is claimed that the latter perspective is becoming more and more important as technology and organizations increase its complexity. Increasing number of materials, product interfaces, ICT implementations, service contents, sustainability criteria, suppliers and collaborators – all adds uncertainties and thus complexity to the manufacturing system. In inter-organizational learning, where learning across firms intends to reduce level of uncertainty, there is expected that organizations in value chains adapt and change accordingly. Learning across firms can help organizations increase their capabilities and capacities in order to innovate faster at product, process and system level. A general advice towards establishing inter-organizational learning among organizations is that strengths, weaknesses, challenges and opportunities among the actors should be defined. Defining focus areas and clear goals are recommended to create efficient and trustful interorganizational networks, where rules and practices for all the organizations

to follow can help make shared knowledge-creation and sharing less challenging. Creating a high degree of synergy and interdependency should also be sought of, additionally, investigating what kind of knowledge is needed both internally and externally.

Collaboration platforms for interorganizational learning in the maintenance department in the three manufacturing companies can be divided into the regional cluster, supplier base and international production network. For the former, informal and irregular interactions is reported, where tacitness is the common learning mode, and where frequency and number of connections are declining due to cluster evolution. The reasons are plentiful - from scarcity of resources to be allocated to external activity, to limited information about what their neighbors do, and that sufficient information is to be found at other sources as for instance through their supplier base or sister plants. The strongest inter-organizational learning platform is the supplier base. Here, frequency, number of contact points, formality and insights with regards to Industry 4.0 are common parameters among all three case companies. All companies say they want to increase their number of interactions with externals at all collaboration platforms, believing that the way forward is about combining formal vs informal work modes in relations to other companies in clusters and value chains to keep up the technological phase. All three case companies particularly claim to have too little formal interaction with their neighbors in the defined regional industrial cluster, a potential low-hanging fruit to increase their learning component.

The future maintenance departments as an inter-organizational learning node must comply to the criteria; awareness and understanding of system interconnections in their near and distant proximity, cause-and effect understanding upon process and product development internal and external, overview of expanding areas of generic technology developments, improved skills to become better problem-solvers with a more holistic perspective.

Interacting with organizations that are different, or contrasting, can foster new ways of approaching challenges and questions. New insight from heterogeneous organizations can help develop entirely new work modes and practices. Contrasting and diverse knowledge can also be acquired. This can bring new and unique ideas to the organization, which can be combined with the existing base of experience and knowledge, creating a potential for generating new ways of exploiting learning situations. However, our findings somehow support a study by Holmqvist that interorganizational learning is similar to intraorganizational learning, where differences in learning conditions seem to depend upon degree of collaboration rather than the kind of collaboration[12]. The study gives practical advice to companies about awareness of interorganizational learning on parameters such as sources, frequency, role, value, relevance. This can be viewed in accordance with for instance a study by Gibb et al, claiming a situated learning approach along the dimensions "learning to perform" and "learning to compete"[13]. In such, awareness is stage one towards utilization of the learning in products, processes and systems that increase competitiveness of the firm.

Some general considerations on interorganizational learning is that it can help increase the resource management in the value chain. Thus, interorganizational learning can contribute to release resources, it can help understanding where resources are

originated, how they should be utilized, and how practices can be learned, shared and implemented.

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