Customer-Supplier Collaboration in Casting Industry: a Review on Organizational and Human Aspects

Taneli Eisto and Venlakaisa Hölttä

Abstract—Customer-supplier collaboration enables firms to achieve greater success than acting independently. Nevertheless, not many firms have fully utilized the potential of collaboration. This paper presents organizational and human related success factors for collaboration in manufacturing supply chains in casting industry. Our research approach was a case study including multiple cases. Data was gathered by interviews and group discussions in two different research projects. In the first research project we studied seven firms and in the second five. It was found that the success factors are interrelated, in other words, organizational and human factors together enable success but not any of them alone. Some of the found success factors are a culture of following agreements, and a speed of informing the partner about changes affecting to the product or the delivery chain.

Keywords—Casting industry, collaboration success factors, customer-supplier collaboration, supply chain collaboration.

I. INTRODUCTION

IN literature is discussed that firms collaborate in supply chains (SC) to achieve mutual objectives by sharing information and resources [3], [10] and heading for greater success than acting independently would enable [20]. Besides, collaboration enables combining customer's and supplier's expertise on designing and producing components. This provides significant possibilities because, according to Danilovic [8], in many manufacturing firms supplied components form approximately 80% of the cost of manufacturing. Furthermore, collaboration can be seen as two or more firms exchanging information [18], making decision together [23], and solving problems together [21]. The goal of collaboration is generating added value to the firms in the network [5].

This paper presents organizational and human related factors that enable well performing collaboration in manufacturing supply chains in casting industry. It is widely accepted that collaboration can be beneficial but Min et al. [16] present that not many firms have truly utilized the potential of collaboration. For example, casting industry supply chains are mostly order-delivery driven without a

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deeper collaboration [9]. Therefore, success factors of collaboration are relevant issue to discuss. Some of the found factors are a culture of following agreements, and a speed of informing the partner about changes affecting to the product or the delivery chain. This paper concentrates only on collaboration between a customer firm and a supplier firm.

The paper is structured as follows. Firstly, related research about collaboration benefits and organizational and human factors of successful collaboration from various industries are presented. Secondly, the research methods are described. Thirdly, the results of the paper, in other words, organizational and human related success factors for customer-supplier collaboration in casting industry are presented. Fourthly, the results are discussed and limitations presented. Finally, the conclusion is formed and future research issues proposed.

II. RELATED RESEARCH

A. Benefits of Supply Chain Collaboration

Collaboration between firms is suggested to benefit product development and production through merged expertise and knowledge. Collaborative customer-supplier relationships are claimed to increase the efficiency and effectiveness of supply chain compared to non-collaborative [16], [17]. In the same way, collaboration in supply chain is suggested to yield significant benefits, such as, reduced inventory, better quality, improved delivery, reduced costs, shortened lead-times, faster product-to-market cycle times, higher flexibility, better demand planning, increased responsiveness to market demands and customer service, market share increases, and new knowledge and skills [6], [15], [16].

Sharing information between partners is one key issue for achieving benefits of collaboration in supply chain. Vereecke and Muylle [24] claim that performance improvement related to cost, flexibility, quality, and procurement can be achieved through information exchange. Information sharing is utilized, for example, in early supplier involvement (ESI). ESI is a beneficial way of collaboration because partner companies' expertises are merged in the early phase of a process, enabling quality improvement, and cost and time reduction [9]. Also, Lee et al. [13] present that information sharing in the supply chain has resulted in substantial inventory reduction and cost savings.

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B. Organizational Collaboration Success Factors

One main prerequisite for successful supply chain collaboration is shared understanding what organisations are going to collaborate over and mutual agreement of the goals of collaboration [12], [1]. As an illustration, clearly defined processes, a clear understanding of the information required implementing such processes, product technical specification, and inter-organizational development process are mentioned as core elements for mutual agreements [1], [12]. Moreover, it is claimed that only after these agreements technology can give added value to collaboration [11].

Kern and Kersten [12] present that common goals can be defined only if companies are willing to discuss their needs openly. A culture of openness and honesty is mentioned as prerequisite by other authors also (e.g., [22]). Openness and honesty enable, for example, the visibility of true customer demand [2], and early reporting if delivery is going to be late [1]. These kinds of actions enable the companies to make replacing plans if new information differs from the old one.

One major issue for building a successful collaboration is creating mutual trust [12], [1], [17]. Trust can be created by contracts to a certain point but real trust develops during time and ongoing collaboration [12]. To create and maintain trust it is essential to share the costs and benefits of collaboration fairly [17]. Nevertheless, differences in organizational cultures hinder trust building [12]. Daniel et al. [7] claim that successful collaboration among firms depends on bridging the differences of organizational cultures. Different organization cultures can cause problems in a way of differences in decision-making processes, values, ways of thinking, and measurement systems [12]. Barrat [1] presents that one of the major supporting elements of collaboration is a collaborative culture, which consists of a number of elements: trust, mutuality, information exchange, openness, and communication.

Commitment to relationship from both partners is important for successful collaboration. If another one is less committed it can lead to frustration that causes the partnership run into problems [17]. Collaborative partnerships need mutual long-term commitment to continuous improvement where the satisfaction of a partner plays a key role [7]. To increase success possibilities firms must consider their operations from the whole SC's point of view instead of a single firm's view [25]. Additionally, Barrat [1] claims, that collaboration is more efficient if firms concentrate on a small number of close relationships rather than a large number of relationships. He also suggests that a supply chain segmentation approach, based on customer buying behavior and service needs, is the most appropriate context for collaboration [1]. Customer's buying behavior can be problematic for a relationship if the behavior does not support collaboration. In fact, components differing, for example, in complexity and importance to a customer should be procured with a different kind of processes to enable collaboration or finding the lowest price depending on the case [9]. In addition, Chan et al. [4] claim, that unequal power relationship between firms results in collaboration challenges.

C. Human Related Collaboration Success Factors

Organizations are dependent on humans, thus, human behavior has a big role in successful collaboration. Successful collaboration requires sharing critical information between partners where, according to Daniel et al. [7], individual's willing and effort to share information is critical. Individuals' communication behavior has influence on satisfaction and commitment to collaboration [7], because individuals are the ones who communicate. Furthermore, SC collaboration runs in difficulties if people fail to understand each other, do not know when and with whom to collaborate, or do not trust each other [1].

Shridhar and Ravi [19] present that in today's collaborative environment the real time interaction is needed. Employees need to be able to respond quickly to partner company's employees' connections. Quick informing about changed situation increases satisfaction and improves productivity [5], because a partner can utilize the information immediately. However, irrelevant information sharing may be harmful [24], thus, people should not share all the data they have but to share only relevant information. In fact, sharing too much data or irrelevant data can cause extra costs, increased inventory, slow response, and lost profits [14].

III. METHODOLOGY

This paper is combined using results from two research projects. Those projects were empirical primary researches and the research approach in both was a case study with multiple cases [26]. The first research project included seven companies, four foundries and three customer companies. The second research project included five companies, one foundry and four customer companies. Interviewed people in the foundries represented top management, sales, and casting design. The customers' interviewees represented procurement, product design, production management, and quality management. All the companies were located in Northern Europe. One of the foundries was a part of a larger corporation and other foundries were small or medium-sized firms. Foundries used different casting processes, for example, sand casting, and die-casting. Customers were large, medium, and small size firms operating in the area of machine building industry, construction industry, and electronic component industry.

The data was gathered by semi-structural interviews and group discussions. Altogether 44 people were interviewed and some of them several times. For group discussions several representatives from different firms were collected to discuss about supply chain collaboration in casting industry. There were various positions represented, for example, top management, sales, casting design, purchasing, and product design. Firm representatives discussed the topics in small groups in the following combinations: foundry representatives with other foundry representatives, foundry representatives with customer representatives, same position representatives

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with each other, and different position representatives with each other. Group discussions were also summed up in bigger group where all participants were present.

The interviews and group discussions were recorded and notes made during them. The recordings were transcribed and added to a research database. The data was analyzed and classified with selected keywords using software which is designed for data analyzing. Each case was first studied individually and then the case results were compared and conclusions drawn.

IV. RESULTS

A. Organizational Collaboration Success Factors

To make collaboration successful both, customer and supplier organizations, need to be able and willing to help and support each other. A supplier must be able to design components and work in collaboration with a customer because the customer is usually not an expert on designing the components the supplier manufactures and hereby needs support. Often it is a requirement for an order that a foundry helps in casting designing. Furthermore, firms' willing to improve procedures and processes need to be two ways. One example of supportive collaboration was in one case where the companies had a quality problem in components but nobody knew which part in the SC caused it. As a solution, these companies shared the cost of scrap parts. In addition, to improve performance one customer company always trains its new supplier to understand the needed actions the components require to achieve the demanded quality level. To succeed in this, they place a designer in supplier's premises for the prototype and production ramp-up phases. In one case this time was one week and both companies were satisfied by the results of collaboration, for example, less scrap in ramp-up phase.

The companies had different opinions whether a partner organization's size would effect to collaboration. Some of the companies did not see it would be any easier to collaborate with small or large companies. However, some interviewed companies thought there is a big difference depending on the size of the organization. They felt that with small companies the communication is easier and faster because they know who to contact and questions are not moved from one employee to another. In fact, many customer companies felt that smaller suppliers are better because the customer is more important for small suppliers and their orders will be in high priority also when there are capacity problems. As an illustration, some customer companies had examples where a large supplier organization had delayed their orders because the supplier served bigger customers first. In brief, general opinion in customer companies is that if they have a chance to choose they only do business with suppliers who are really interested serving them. Additionally, one customer representative mentioned that they have had situations when a big supplier organization has not been willing to do prototypes for them because the final volume of components is not known yet, but a small supplier has been willing even if the final volume will be lower than expected.

Trust between partners was found to be a critical factor for successful collaboration. Trust enables open communication and information exchange between partners which are also factors for successful collaboration. Open communication enable, for example, demand forecasting and collaborative designing. Similarly, trust enables suppliers to work for a customer knowing their work will be compensated one way or another. In addition, supplier organizations must have a strong culture of keeping their promises, especially agreed schedules. As an illustration, very harmful for partnership is if another party promises to do something but does not inform immediately when the promise cannot be kept. If the promise cannot be kept and it is not informed to another party immediately, there might be time wasted which can cause delays resulting in the loss of trust.

Customers mentioned that suppliers should be honest in their pricing. They had examples where a supplier has been interested to participate in a project and has committed to certain prices and volumes. But after one year the supplier has told that the price or the volume must be increased because production costs are higher than expected. At this point, it is costly for the customer to change supplier but trust is gone with the current one. Therefore, customers pointed out that suppliers need to be able to give price spread that holds, because they are experts in their own business.

Openness of organizational culture is important for collaboration. Suppliers mentioned that it would be important to know what bases the customer chooses the supplier. In one case, a supplier had had a lot of new orders from a customer but the reason was not clear. In this case it is difficult for the supplier to develop and provide more value to the customer because the supplier does not know what the customer values in its performance. Furthermore, suppliers would want honesty from customers in a way of early warnings if a customer is not satisfied with them. Suppliers felt it unfair that if the component was designed together that suddenly the customer tells that price is the only thing that matters and changes to a cheaper supplier.

One prerequisite for successful collaboration is that a supplier is willing and capable to understand and serve its customer. First of all, suppliers should segment their possible customers and decide who they can and want serve the best. For example, different volumes and component shapes fit better to different manufacturing methods. Therefore, suppliers should focus their resources to the chosen group of customers. Additionally, partner firms should discuss openly about needs and possibilities to find the best fitting ways to serve the customer. In the interviews was found several ways to serve a customer. One was to serve clear material information to customers who have not used before the material that supplier offers. After all, material affects on the using possibilities and durability of a component. Another was to find fitting way to handle deliveries, stocks, and invoicing. There were several ways available. For example, many

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customer companies wanted to lower their own stocks. Many customers also wanted to decrease the number of their first tier suppliers meaning that, for example, casting, machining, and surface finishing is wanted to buy from one supplier. Thus, suppliers need to network with other supplier companies. In addition, customers wanted to give easy assembly jobs to suppliers to simplify their own production. Additionally, die casting component production uses moulds and a normal practice is that a customer owns the moulds. This is problematic for a customer firm because moulds are expensive thus increasing the starting cost of subcontracting. Subsequently, this turns into a supplier's harm, because expensive moulds are often a reason for a customer to order castings from a low-cost country where moulds are cheaper. The organizational success factors presented in this section are summarized in table 1.

B. Human Related Collaboration Success Factors

One prerequisite for successful collaboration is the speed of responding to partner's contacts and informing the partner if something happens that differs from planned. As an illustration, many customer representatives demanded that supplier's contact person must react quickly to the customer's e-mails. Additionally, supplier's contact person should inform the customer immediately about problems if they affect to schedules or quality. For example, in die casting quick informing about quality problems is extremely important because volumes are high and the error will be reproduced several times in a short time. Further, some customer representatives mentioned that they do not do business with suppliers who are too slow to respond. In contrast, customer's contact person needs to inform a foundry quickly if there will be a change in component's design. Thus, production of old versions can be stopped.

Openness in discussion and information sharing was mentioned to be one success factor for collaboration. In fact, good personal relationships and trust enable early and open discussion. For example, a customer can ask informal question (e.g. price level or opinion for design) from a supplier before there is a formal contract. When there are good personal relationships, suppliers also give voluntarily improvement suggestions for a customer at a request for quotation phase. In addition, honesty was mentioned to be a factor that makes collaboration easy between two people. The interviewees described a difficult person to be such who does not give straight answers quickly. If a person does not answer, the sender of the question does not know if the other one has got the message or not (e.g., e-mail). This may cause delay in schedules if the answer is needed to start following actions.

TABLE I
ORGANIZATIONAL SUCCESS FACTORS OF CUSTOMER-SUPPLIER
COLLABORATION IN CASTING INDUSTRY AND EXAMPLES OF THEM

Success factor	Example
Mutual interest for collaboration; including ○ Willingness to improve	-Supplier prioritizes the customer's orders - Customer trains supplier in
collaboration ○ Partnership thinking	problematic issues -Risks and rewards of collaboration are shared
Ability to provide value to another company	-Supplier provides value through expertise in component design that a customer does not have
Mutual understanding of requirements	-Firms go through the requirements of a component and trains if needed
Mutual trust; enabling ○ Open communication ○ Open information exchange ○ Collaboration with light contracts	-Partners share information openly and early in the process, even without formal contracts
Culture of following agreements	-Customer agrees for a certain sized order if a supplier assists doing a component design; Customer sticks in it even some other supplier offers lower price. -Supplier agrees to deliver components in a certain date; Supplier keeps it or informs immediately if the promise cannot be kept.
Culture of open discussion; including ○ Informing of problems ○ Being honest with promises ○ Giving honest feedback ○ Discussing needs and possibilities	-Supplier informing delays up front -Agreeing prices and volumes so that they hold -Customer telling supplier selection criteria -Giving continuous feedback for developing
Selecting appropriate partner	-Through partner segmentation firms can collaborate with firms fitting them the best

Attitude for collaboration is one success factor. In particular, customer representatives hoped that suppliers would show their devotion to collaborate with the customer, for example, by commenting the customers design. On the contrary, a customer's employees' attitude affects on the results of collaboration. One example was a customer's designer who spent one week in a supplier's premises giving tips how to manufacture the components. Furthermore, the interviews revealed that in some cases customer designer's good skills in casting design weakened collaboration. Apparently, when a customer designer had more experience in castings he designed them longer without a foundry designer's help, which resulted in less communication and poorer collaboration. This increases possibility for relevant information missing that a foundry could provide. However, late contacting did not concern all designers. The human related success factors presented in this section are summarized in table 2.

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TABLE II
HUMAN RELATED SUCCESS FACTORS OF CUSTOMER-SUPPLIER
COLLABORATION IN CASTING INDUSTRY AND EXAMPLES OF THEM

Success factor	Example
Speed of responding and informing; including o Quick reacting to customer's contacts o Quick informing of problems affecting to schedules or quality o Quick informing of engineering changes	-If a supplier's contact person informs a customer about delay the customer will not reserve assembly equipment in vain. -If a customer's contact person informs a supplier quickly about EC the old version of the component is not produced in vain.
Open communication; enabled by o Good personal relationships o Honesty	-Good personal relationship enable informal communication between people (e.g. asking for advice without a formal contract) -Honesty help people to trust each other and communicate openly
Attitude for collaboration; including o Willingness to help o Willingness to communicate and ask for help	-Supplier's designer giving the best advices for a customer's designer -A customer's designer giving all the information a supplier's designer needs to design the component -The earlier partners communicate the better the results

V. DISCUSSION AND LIMITATIONS

The interviews revealed the need for mutual interest for collaboration. This is crucial because companies should be able to consider their operations from the whole SC's point of view instead of a single company's view [25]. After all, companies are able to achieve better results by collaborating than individually [7]. Like the examples in the results section showed, when there is mutual interest for collaboration, companies can share risks and resources, thus, improving their satisfaction and performance level. Similarly, Vereecke and Muylle [24] have found that increased collaboration often results in improved performance.

Size difference between companies was seen as a challenge by some interviewees but not all. The most important thing is that both firms are willing to invest in a collaborative relationship. For example, it is both parties advantage when the customer's orders are in high priority to supplier; delivery reliability is high and, thus, the customer probably orders more from the supplier. Descriptive for the importance of attitude towards collaboration is a statement from the interviews that if a customer has a chance to choose they only does business with suppliers who are really interested serving them. However, Chan et al. [4] have stated that unequal power

relationship will probably cause challenges. Additionally, different sized companies often have different kind of company cultures. In interviewed companies a difference in company cultures was not seen as a challenge, unlike Kern and Kersten [12] and Daniel et al. [7] who claim that differences in company culture hinder collaboration.

Trust between partners appeared to be a critical factor for successful collaboration, which is supported, for example, by [12], [1], and [17]. Trust enables open communication which is found necessary in this research and also by [12] and [22]. By communicating and exchanging information openly companies can work more efficient because it enables demand forecasting, collaborative designing, and a real time informing of problems (e.g. [2], [1]). If the partners cannot trust on others promises, being informed of problems and changes, or getting compensated from their work, the relationship will not develop added value as much as it could.

Culture of following agreements is necessary for getting long-term benefits. Customers had examples where a supplier had been committed to certain prices and volumes, but after the investments to collaboration had been made the supplier demanded price or volume increasing. This kind of behaviour shows short-term thinking instead of interest to collaboration. Trust is gone if other one does not follow the mutually agreed rules. Instead of short-term profit maximizing companies should strive for the whole SC's benefit. One way to strive for SC's benefit is open pricing. This enables also sharing benefits and costs of collaboration fairly, which is necessary to maintain trust [17].

Culture of open discussion is necessary if companies want to develop their relationship. If companies do not tell what they really need there is no possibility for a partner to know how to perform better. Suppliers felt it frustrating that customers do not tell on what basis they choose their suppliers. In this kind of case a customer gets poorer service than it could if it told to customer how to develop. As a result, the customer may go after the cheapest component price instead of developing the current relationship to achieve a better performing SC and decrease total costs. Similarly, in designing a supplier cannot consider all the options, if a customer has not given enough information about the component and its surrounding. Openness is needed from supplier also. If a supplier runs into problems with a component delivery but does not inform a customer, it can cause a lot of needles work. For example, if a customer does not know about the delay in delivery and has already reserved machinery capacity then time is wasted because the components are not delivered and the machines stand empty. Like Parker [17] presents, one party's lower commitment leads to a frustration of another.

A supplier needs to understand customer needs to be able to fill them. However, customers have different needs and that is why the supplier should segment customers and decide what kind of customers it wants to serve and concentrate on those. Barrat [1] suggests that a supply chain segmentation approach based on customer buying behaviour and service needs is the

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most appropriate context for collaboration. When a supplier is capable to serve a customer then open discussion is needed. An example of poor communication is that one customer glued additional parts to castings whose drying took a long time and caused challenges to production flow. If a supplier had done that, the drying could have happened during the transfer from the supplier to the customer. The gluing was not outsourced because the customer and the supplier did not communicate openly and they just had not ever talked about the gluing issue. In addition, many die-casting customers had started to ship castings from low-cost countries because mould prices are much cheaper there which leads to lower starting cost of subcontracting. For this reason, foundries in higher cost countries should build up new services to decrease customers feeling of high subcontracting starting cost and discuss about these services. For example, foundries could sell moulds by partial payment, when a customer did not need to invest that much capital in the starting point of subcontracting. A foundry could also collaborate with a finance company that owns and sells a mould in partial payment when neither the foundry nor the customer needs to do a big investment on the mould at once.

It was mentioned several times in the interviews that communication between firms need to be fast (e.g., [19]). It means that both firms' contact persons need to be able to answer quickly to other ones questions. Similarly, contact persons need to inform partner company's employees quickly if something happens that differs from planned. This supports Cho et al.'s [5] finding that quick informing about changed situation increases satisfaction and improves productivity. Likewise, contact person's behaviour was seen important by Daniel et al. [7] who present that individuals' communication behaviour has influence on satisfaction and commitment to collaboration.

One success factor for collaboration was found to be open communication (e.g., [1]). In the interviews difficult person was mentioned to be the one that does not communicate openly and give quick answers. Not answering quick and openly can be a personal or an organizational habit. This person who does not answer might be too busy or wrong person to answer this particular question. For instance, if the authority of making decisions is taken too high in organization, for example, to CEO, one might not have time to handle everyday problems of these issues. In the same way, a buyer is a wrong person to discuss about quality issues because the buyer does not have the authority to decide issues related to quality. What need to be noticed is that communication should not be limited between two contact persons. It can be clear like that but does not fit to collaboration where fast action is important.

Attitude for collaboration was found to be one success factor. Contact persons in design phase need a lot of technical understanding but sometimes it affects negatively to collaboration through attitude. In some cases where a designer was experienced to design castings he communicated less with foundry designers, which caused late contacts and poor

communication increasing possibility to miss relevant information that the foundry could provide. However, some experienced designers contacted always foundry designers in early phase. Similarly, Daniel et al. [7] present, that individual's willing and effort to share information is critical for collaboration. In addition, what was mentioned to be the most valuable collaboration was the case where a customer's designer went to a supplier's premises offering help in problematic issues with the component.

Organizational success factors are implemented by humans in the end. If there is mutual interest for collaboration at an organizational level there is still need for humans to implement this interest in practise. That is why people need the right attitude for collaboration. Also, ability to provide value does not happen without people's attitude to provide that value in each case. Further, achieving mutual understanding of requirements need open communication between people. In the same way, achieving mutual trust requires both parties' people to have the right attitude, open communication, and fast reacting to each others' connections. Additionally, cultures of following agreements and open discussion become reality not until people in the organization act based on those principles. People also make decisions with whom the organization will collaborate. In contrast, humans need organizational factors to be in order to implement successful collaboration.

Limitation for generalizing our results is that our case companies were from a small geographical area. In addition, organizational and human factors are only a part of the factors affecting to collaboration, for example, technological factors were not observed.

VI. CONCLUSION AND FUTURE WORK

It can be concluded that organizational factors create a base for successful collaboration but only with human related factors collaboration can be implemented successfully. Organizational and human factors are in a relation and replenish each other. In other words, if organizational factors are not in order human factors cannot make collaboration successful. In the same way, if human factors are in poor condition, organizational factors will not make collaboration successful. The organizational and human factors and their interdependence are presented in figure 1.

Collaboration in casting industry is an important issue for future research because through collaboration can be developed competitive advantage. One issue for further research would be to extend knowledge about success factors of collaboration. Another issue for further research would be to clarify what casting customers' employees (e.g. production manager, purchaser, design manager) value when they choose a supplier, and then compare if the suppliers are chosen based on narrow perspective or total view. In addition, clarifying how to focus suppliers' expertise at the right time in customer's process to add maximum value would be relevant.
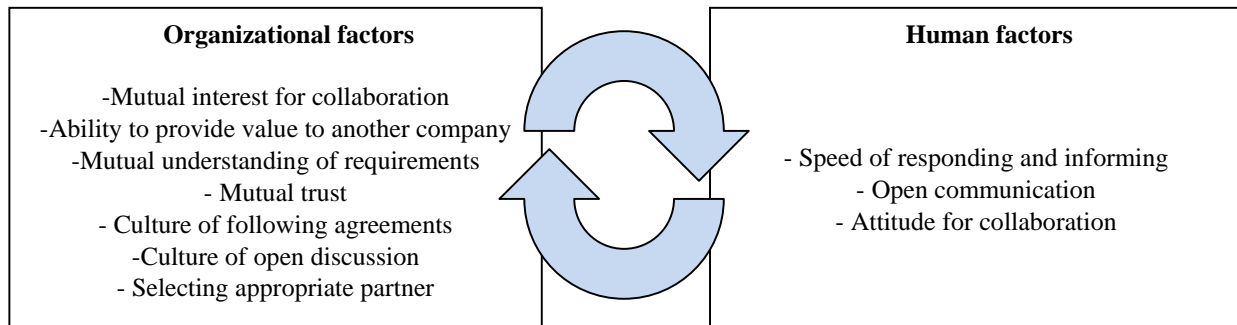
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Organizational factors

-Mutual interest for collaboration
-Ability to provide value to another company
-Mutual understanding of requirements
- Mutual trust
- Culture of following agreements
-Culture of open discussion
- Selecting appropriate partner

Human factors

- Speed of responding and informing
- Open communication
- Attitude for collaboration

Fig.. 1 Organizational and human related factors of successful collaboration in casting industry

Additionally, a measurement system for the advantages of collaboration should be created because they are difficult to measure accurately.

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