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Croatian Defense Industry Competitiveness Cluster: Knowledge Management and Innovation Perspective

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Abstract

Background: Industry clusters and their relationship with the organization's success, competitive advantage and innovations have been gaining research interest for decades, with the recent focus on defence industry. **Objectives:** The aim is to investigate how Croatian Defense Industry Competitiveness Cluster (CDICC) fosters the knowledge management and innovation performance of its members. **Methods/Approach:** Survey has been performed on a portion of CDICC members, and responses have been analysed using the factor analysis and the correlation analysis. **Results:** The results indicate that CDICC actively contributes to knowledge creation and acquisition, innovation performance and market performance of its members. However, the analysis revealed that knowledge storage and knowledge dissemination are not sufficiently supported by CDICC. **Conclusions:** The current problems with the various aspects of knowledge management within a cluster provide a direction for overcoming possible obstacles for further development of industrial clusters.

Keywords: defence industry cluster; knowledge management; innovation performance; Croatian Defense Industry Competitiveness Cluster; factor analysis
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Introduction

Competitiveness industry clusters has become a major trend in modern organizations, as well as in the defence industry, since industry clusters support the synergy between companies operating in the same field of expertise and in close geographical proximity. Competitiveness industry clusters have many advantages, such as economies of scale as well as the increased cooperation (Porter, 1998), but without the loss of flexibility which often emerges with the increase in size. Competitiveness industry clusters have also a significant impact to knowledge management, which is relevant due to the strong impact of knowledge management to companies' performance especially innovation (de Hoog, 2009).

Competitiveness industry clusters in the defence industry emerged in the last several decades in large number, fostered by opportunities that such cooperation provides for the development of innovative products and new markets' penetration. In Croatia, which is a post-transition country, such cluster emerged several years ago, entitled as Croatian Defense Industry Competitiveness Cluster (CDICC). The objective of this research is to investigate the impact of industry defence clusters to the knowledge management and innovation performance of its members, using CDICC as a case study. In order to get insight into this area, we have conducted the analysis of strategic documents of CDICC, and a survey research on a sample of CDICC companies. Factor analysis and correlation analysis were used in order to investigate a support of industry cluster to its members in the areas such as innovation performance and knowledge management.

Literature Review

Knowledge management came into research focus in the mid-1990s (de Hoog, 2009). Its various definitions describe main aspects of knowledge manipulation in an organization and main processes that focus on: knowledge creation and acquisition, knowledge formalization and storage, knowledge sharing and using (Dominguez Gonzalez, & Martins, 2017; Girard, & Girard, 2015). Inter-organizational transfer of knowledge is also very important (Easterby-Smith, Lyles, & Tsang, 2008) because relationships with other organizations and access to supplementary knowledge have positive impact on innovation performance and competitive advantage (Knudsen, 2007), as can be seen in organizations that are connected in so-called clusters (Tallman, Jenkins, Henry, & Pinch, 2004).

Porter (1998) states that clusters are "geographic concentrations of interconnected companies and institutions in a particular field" (p. 79) that foster productivity, innovation, and development of new businesses. In Europe, much effort is being made towards strengthening clusters and cluster policy and a platform for helping clusters' collaboration is developed as an aid for finding new partnerships (Ketels, Lindqvist, & Sölvell, 2012).

Several studies demonstrated that knowledge management related activities and processes have a positive influence on the innovativeness of organizations in various settings, such as Taiwan top companies (Chen & Huang, 2009), New Zealand organizations with more than 50 employees (Darroch, 2005) and Spanish companies from high and medium-high technology sectors (Luengo-Valderrey, & Moso-Díez, 2016). Relationship with knowledge management and its positive influence was proven for various sectors, such as Iranian manufacturing factories (Ebrahimi Mehrabani, & Shajari, 2012), mobile telecommunication companies in Jordan (Hajir, Obeidat, Al-dalahmeh, & Masa'deh, 2015), Brazilian information technology industry

(Junges, Gonçalo, Garrido, & Fiates, 2015), and Nigerian hotel industry (Lasisi & Dabiri, 2015).

Special attention has been given to the small and medium-sized enterprises (SMEs and mid-caps). For example, Valdez-Juárez, de Lema and Maldonado-Guzmán (2016) conducted research in Spain that showed that more effort in several knowledge management elements positively influences innovation performance of SMEs. Another research of SMEs by Price, Stoica and Boncella (2013) found the differences in the influence of innovation and knowledge on business performance between family and non-family firms.

Two decades ago, it was shown that firms in geographical industry clusters are strong (larger own-sector employment) and have more innovative activity (Baptista, & Swann, 1998). The impact of clusters on organization, innovation and performance, in general, has also been researched from various aspects, for specific industries and different types of organizations. Part of the research is performed for several clusters together, mostly different in one industry and sector. The survey of industry clusters in six special economic zones in Taiwan detected various cluster relationships and their positive impacts (Hsu, Lai, & Lin, 2013). Chang, Tsai, and Henderson (2012) performed research in three science-based parks in Taiwan, concentrated on business performance and how it is effected by knowledge innovation capability, clusters, and also by regional innovation systems (Chang, Tsai, & Henderson, 2012). Similar relationship between knowledge management and innovation performance, which was confirmed for industry cluster members (Lai, Hsu, Lin, Chen, & Lin, 2014).

Blanvillain, Hurard, Mazari, and Degres (2014) showed that each of three aeronautics clusters from different countries, mostly comprised of SMEs, and has its own innovative practice. Another research in this filed showed a low to medium level of open innovation in the Brazilian aerospace industry cluster (also mostly SMEs) (Armellini, Kaminski, & Beaudry, 2014). Impact of the access to cluster's resources (Prim, Amal, & Carvalho, 2016) and involvement in overlapping cluster organizations cliques (Lerch, Provan, & Sydow, 2008) on innovation was also researched, first for Brazilian manufacturing industry cluster, and second for photonics cluster in Germany. SMEs are also of interest in discovering the interconnection of clusters and innovation, for example, a research of Greek manufacturing SMEs (Vassakis, Voulgaris, Xekardakis, & Lemonakis, 2015), and of small cluster TenunCual Union (Aryanto, & Fransiska, 2012).

Defence industry clusters gather mainly small to medium-sized enterprises (SMEs) trying to overcome their size caused disadvantages, such as lack of resources, although they are influenced by political, social, economic and security conditions of the state and many important factors, such as government bodies or agencies (Erenel, Demir, & Caymaz, 2015). Defence systems export can largely contribute to national income, as an example of defence cluster in Turkey shows (Demir, Caymaz, & Erenel, 2016). Guillou, Lazaric, Longhi, and Rochhia (2009) compared organizations that are not in the defence industry, those that are and those that are additionally funded by it, and found out that the last group was more knowledge management-oriented and had higher level of innovation. Briones Peñalver (2013) shows trough analysis of the Spanish defence industry that this industry is an agent of research, development and innovation through knowledge management activities, with its own economic structure and innovation as business strategy, where results of defence innovation system are transferred to civil applications.

Therefore, it is understandable that there are several formal defence industry clusters in Europe, for example, Centre for defence, space & security in Denmark, Estonian Defence Industry Association, EDEN Cluster and Toulouse Midi-Pyrénées Defence and Security in France, and CDICC in Croatia.

The defence industry is closely connected to innovation and, as was stated above, many clusters in this industry are formed. In spite of that fact, research about the relationship between innovation and products in the defence industry is mostly oriented on knowledge management in general, and there has not been any substantial research regarding the relationship of clusters with innovation specifically for the defence industry.

Background

Croatian Agency for Investments and Competitiveness is the main body that formally establishes competitiveness industry clusters, and defines them as follows: "A competitiveness industry cluster is a sector-specific non-profit organization, identified and established on the initiative of the Government of the Republic of Croatia, which brings together the commercial, scientific and policymaking communities in a formal structure" (Croatian Agency for Investments and Competitiveness, 2016). On its web page, Croatian Agency for Investments and Competitiveness lists 13 competitiveness industry clusters in Croatia from various industries, for example, food processing, automotive, medical, ICT, as well as defence.

Croatian Annual Report on Export and Import of Military Goods and Non-Military Lethal Goods for 2015 also shows an increase of export/transfer since 2014 for 36.8% (Ministry of Economy, Entrepreneurship and Crafts, 2016).

CDICC (2017b), gathers approximately 50 members (number varies with new and leaving members; there were 46 at the time of research), divided into three sectors: private sector and business clusters, public sector and professional organizations and associations, and lastly science and research sector. Its mission is aimed at the development of new technologies and innovative products for the domestic and international market that should improve defence potentials (CDICC, 2017a, 2017c). Its activity is largely directed by the following strategic documents: Industrial Strategy of the Republic of Croatia 2014-2020, Strategy of Support to Innovations of the Republic of Croatia 2014-2020 and Smart Specialization Strategy. Croatian research and development investments, as well as interconnections between research institutions and business sector, are below EU average and clusters are therefore important for competitiveness, including security as one of five priority areas, where CDICC has the most important role in defence (Government of the Republic of Croatia, 2016). These strategic documents clearly indicate the importance, which Croatian Government puts on knowledge and clusters to foster innovation, placing CDICC as their focal point.

In order to get more insight into the practice of CDICC, its strategic documents were examined. It was discovered that knowledge management is explicitly mentioned just once and only in the Croatian Armed Forces Long Term Development Plan 2015 − 2024 (Ministry of Defence 2014). However, document search by keywords connected with main knowledge management processes (being knowledge creation, knowledge acquisition, knowledge storage and knowledge sharing) revealed that all strategic documents do place importance on them. Knowledge creation and acquisition both relate to gaining knowledge and keywords connected to them (for example, discovery or generating) are mentioned 23 times in various forms. Knowledge storage ensures forms of knowledge that can be used by anyone that needs it in the system or by sharing and keywords connected with those processes (for example, shaping, transfer or dissemination) are mentioned 24 times. Keyword search for innovations revealed that they are actually mentioned most often (78 times), with explicit goals regarding innovation, pertaining to better market (38 times, for example, commercialization or new markets) and product (40 times, for example,

new products or product innovations) performance. All strategic documents accentuate better competitiveness on markets and expansion into new markets, as well as new and innovative products. These are the main reasons why the defence cluster was formed, and that is why it is important to see whether it achieved its goals, i.e. if it had a relationship with before mentioned concepts. Document search results also revealed that the current relationship only of the cluster as a whole is considered, probably because of the early phase of cluster creation and its slow development.

Taken into account these findings, the following five research propositions are created: (i) RP1: There is a relationship between CDICC and knowledge creation and acquisition; (ii) RP2: There is a relationship between CDICC and knowledge storage and dissemination; (iii) RP3: There is a relationship between CDICC and Innovation performance; (iv) RP4: There is a relationship between CDICC and market performance, and (v) RP5: There is a relationship between CDICC and product performance.

RP1 and RP2 are investigating the CDICC and knowledge management processes relationship, whereas RP3, RP4 and RP5 are investigating the relationship between CDICC and innovation as a whole and its elements connected to market and products. Other elements and connections are not found to be of current importance to CDICC, probably due to its low development stage.

Methodology

Data

The research was performed by using a survey research questionnaire that was distributed among the CDICC members. A total of 46 companies in cluster received the questionnaire; 23 returned questionnaires were usable, while additional 3 were incomplete. This yields a valid retrieval rate of 50%. Among them there are 5 middle-sized companies, 2 large, 12 small-sized, and 4 institutions; ownership wise, 13 are private, 7 are public, and 3 are mixed, and 11 of them all are producing companies. The data were collected in the period from July to December 2016.

We used the items from the research instrument developed by Lai, Hsu, Lin, Chen, and Lin (2014: p. 737), for which authors' permission was obtained. The questionnaire has three areas: the effectiveness of industrial cluster, knowledge management and innovation performance. The original questionnaire had a larger number of questions, but the number of questions was reduced after the conducted analyses. The results section explains how the number of questions was reduced. The final questions for the three analysed areas are shown in Table 1.

Table 1

Research instrument (Likert scale 1-5)

Effectiveness of industrial cluster
The company can easily obtain individuals with talent and with high educational levels.
The company can obtain experienced and required core technique talents.
The company can easily access the knowledge and technology pools of colleges, universities and research institutions.
The company can have vertical cooperation with upstream and downstream firms in order to lower costs.
The company can connect with firms in the supply chain and be devoted to innovative techniques and production.
The company can easily develop strategic alliances.
Effectiveness of knowledge management
The company attaches great importance to knowledge sharing with customers, suppliers and competitors.

The company can quickly obtain information related to new products, services, and markets.
The company establishes special project feedback to improve the performance of future projects.
Employees of the company can obtain data required for work from databases or other members.
The company has complete management mechanisms for professional techniques and knowledge.
The company manages professional techniques, knowledge, and content by a computer system.
Innovation performance
The percentage of commercialization is increased with products and techniques.
Customers of the company have high demand for products and techniques.
Customers of the company are highly satisfied with products and techniques.
Market share of the company increases continuously.
Because of the development of product innovation, frequency of design change and revision is lower.
Because of product innovation development, manufacturing costs of similar products are lower.
Because of product innovation development, time of similar products to the market is shortened.

Source: Lai, Hsu, Lin, Chen, and Lin (2014)

Statistical methods

The goal of the statistical analysis was to determine factors pertaining to three areas: the effectiveness of industrial cluster, the effectiveness of knowledge management and innovation performance. Therefore, three separate factor analyses were conducted for the above-mentioned areas. For the extraction of factors, the principal components approach to factor analysis.

Results

Factor analysis

Factor analyses were conducted separately for all three areas: the effectiveness of industrial cluster, the effectiveness of knowledge management and innovation performance. The results can be seen in Tables 2-4. Scale reliability was assessed using Cronbach's alpha coefficients. As shown in Tables 2-4, all Cronbach's alpha coefficients values were greater than 0.7, which indicates acceptable level of reliability. First, the appropriateness of factor analysis has to be evaluated. For this purpose, correlation matrix and Kaiser-Meyer-Olkin (KMO) measures were calculated. Correlations results reveal that all variables have at least one correlation coefficient with an absolute value greater than 0.4 (significant at 5% significance level). Tables 2-4 show that all KMO values are greater than 0.5. All above-mentioned information indicates the appropriateness of factor analysis.

The first factor analysis (Table 2) was conducted on eleven variables regarding the effectiveness of the industrial cluster, in our case CDICC. 5 variables with loadings smaller than 0.5 on all factors or with loadings bigger than 0.5 on more than one factor were excluded. Final factor analysis was performed on 6 variables. Two factors were extracted based on the Kaiser criterion (both eigenvalues were greater than one; 2.275 and 1.85). These extracted factors explain 68.8% of the total variance; they are related to the cluster support to the relationship development and others are related to the support to resources.

Table 2
Results of factor analysis for the effectiveness of industrial cluster

Factors and variables	Factor loadings
KMO 0.705, Cronbach's α 0.774, Cumulative % of variance 68.80	
Factor 1 – Relationship support, Eigenvalue 2.275, % of variance 37.91	
The company can have vertical cooperation with upstream and downstream firms in order to lower costs.	0.821
The company can connect with firms in the supply chain and be devoted to innovative techniques and production.	0.799
The company can easily develop strategic alliances.	0.728
Factor 2 – Resources support, Eigenvalue 1.853, % of variance 30.89	
The company can easily obtain individuals with talent and with high educational levels.	0.734
The company can obtain experienced and required core technique talents.	0.758
The company can easily access the knowledge and technology pools of colleges, universities and research institutions.	0.802

Source: Authors' calculation

The second factor analysis (Table 3) was performed on sixteen knowledge management variables and ten variables with loadings smaller than 0.5 on all factors or with loadings bigger than 0.5 on more than one factor were excluded. Final factor analysis was performed on six variables and two factors were extracted based on the Kaiser criterion. Both eigenvalues are greater than one (2.572, 1.87). The extracted factors explain 74.1% of the total variance; they are Knowledge storage and dissemination and Knowledge creation and acquisition.

Table 3
Results of factor analysis for the knowledge management

Factors and variables – Knowledge management	Factor loadings
KMO 0.643, Cronbach's α 0.773, Cumulative % of variance 74.10	
Factor 1 Knowledge storage and dissemination, Eigenvalue 2.572, % of variance 42.87	
Employees of the company can obtain data required for work from databases or other members.	**0.813**
The company has complete management mechanisms for professional techniques and knowledge.	0.909
The company manages professional techniques, knowledge, and content by a computer system.	**0.877**
Factor 2 Knowledge creation and acquisition, Eigenvalue 1.874 % of variance 31.23	
The company attaches great importance to knowledge sharing with customers, suppliers and competitors.	0.845
The company can quickly obtain information related to new products, services, and markets.	**0.828**
The company establishes special project feedback to improve the performance of future projects.	0.665

Source: Authors' calculation

The third factor analysis (Table 4) was conducted on ten variables regarding innovation performance. According to the factor loadings and communalities, only three variables were excluded. Factor analysis on 7 variables resulted in two factors, extracted on the basis of the Kaiser criterion (both eigenvalues were greater than one: 3.410 and 1.844). These two extracted factors explain 75.07% of the total variance; they are Market performance and Product performance.

Table 4
Results of factor analysis for the innovation performance and its elements

Factors and variables – Innovation performance	Factor loadings
KMO 0.715, Cronbach's α 0.845, Cumulative % of variance 75.07	
Factor 1 Market performance, Eigenvalue 3.410, % of variance 48.72	
The percentage of commercialization is increased with products and techniques.	0.895
Customers of the company have high demand for products and techniques.	0.776
Customers of the company are highly satisfied with products and techniques.	0.867
Market share of the company increases continuously.	0.835
Factor 2 Product performance, Eigenvalue 1.844, % of variance 26.35	
Because of the development of product innovation, frequency of design change and revision is lower.	0.858
Because of product innovation development, manufacturing costs of similar products are lower.	0.638
Because of product innovation development, time of similar products to the market is shortened.	0.775

Source: Authors' calculation

Correlation analysis

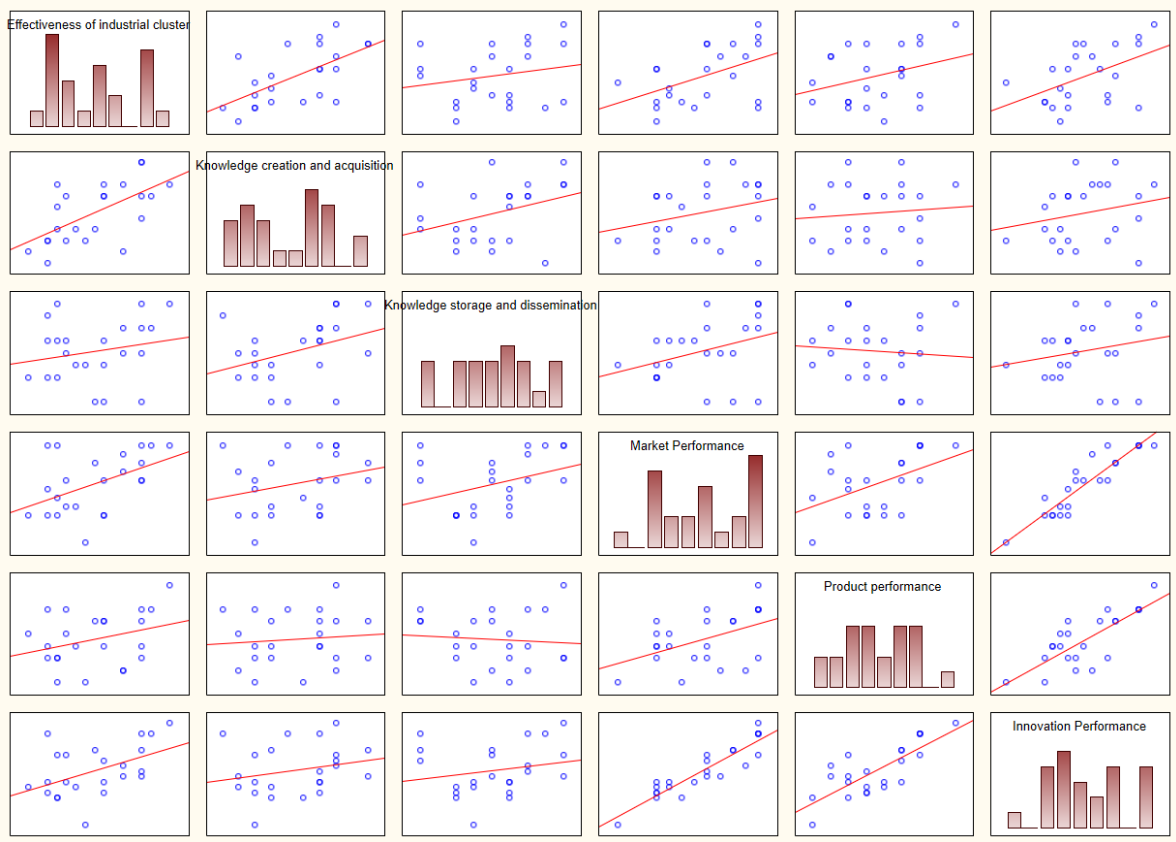
Correlation analysis was conducted in order to investigate further the relationship between variables. For this purpose, extracted factors were used. The results of these analyses are shown in Table 5 below. These results show that the effectiveness of industrial cluster has positive relationship with knowledge creation and acquisition, showing support for RP1 at 5% significance level. The results also show that the effectiveness of industrial cluster has positive relationship with innovation performance, showing support for RP3 at 1% significance level. Finally, the results show that the effectiveness of industrial cluster has positive relationship with market performance, showing support for RP4 at 1% significance level, and the RP5 is supported in a similar manner. Figure 1 presents the distributions of the observed variables and their scatterplot diagrams.

Table 5 Correlation coefficients of effectiveness of industrial cluster and knowledge management and performance variables

Variables	CDICC effectiveness	Research proposition
Knowledge creation and acquisition	0.617**	RP1 – confirmed
Knowledge storage and dissemination	0.202	RP2 – not confirmed
Innovation Performance	0.478*	RP3 - confirmed
Market Performance	0.477*	RP4 - confirmed
Product Performance	0.311*	RP5 - confirmed

Source: Authors' calculation
Note: Number of observations: 23, *p<0.05, ** p<0.01

Figure 1 Correlation matrix of effectiveness of industrial cluster and knowledge management and performance variables



Source: Authors' calculation

Discussion

Importance of knowledge management as a whole still is not recognized in Croatian strategic documents also pertaining to defence sector. However, importance is placed on individual knowledge management processes and innovations, as well as on market and product performance, which is why CDICC was formed. This study was conducted in order to see whether it has relationship between before mentioned concepts because document search discovered that a cluster as a whole is expected to have relationship with them. Therefore, it was important to see whether the set goals were achieved.

Based on the importance placed on knowledge management processes and innovation, five hypotheses were proposed, out of which three were confirmed. Those results show the following contributions of this research.

First, confirmation of RP1 shows that cluster forming has a relationship with the amount of acquired knowledge, which is necessary for further improvement of Innovation performance. This relationship could be even stronger trough Knowledge storage and dissemination, but rejection of RP2 shows that this is currently not the case. What the barriers that prevent this process are remains to be formally investigated, but it is interesting that members do see improvements in knowledge generation, but not in knowledge transfer. This may indicate that they themselves are not as open as they should be to share inside the cluster as opposed to acquiring. In addition, if they consider sharing as problematic, the question is what actual sources of more

knowledge are they acquire. Such problems in knowledge flow can slow down CDICC development and must be resolved.

Second, since Innovation performance is mentioned almost twice as often than knowledge management processes in strategic documents, the confirmation of RP3 shows that an important goal of cluster formation is achieved. This mostly applies to marketing performance, according to RP4. Product performance does not have relationship with cluster, since RP5 is rejected, which shows that cluster members do not base their product development on cluster resources and relations, but on their own research, as they were before they entered the CDICC. On the other hand, according to RP4, they count on CDICC to be their mediator to new markets and better competitiveness. It is obvious that efforts to improve interconnections in CDICC for research and product innovations should be made.

Third, if we look at both findings together, they lead to conclusion that there is a general opinion that knowledge sharing and product performance are not good inside CDICC, and they are very much related, because cluster members poses various knowledge that can affect new products development. Since analysis of strategic documents showed that cluster resources and relations are not recognised as important parts of cluster relationships, it is obvious that those problems first must be resolved at strategical level, so that CDICC members can recognize and fully use all benefits of the cluster.

The limitation of the chosen research approach is the size of the cluster itself and ratio of members in private sector and business clusters to those in research and development sector, which gives the results the view more from the first sector. In addition, the CDICC is in its initial development stage, develops very slowly and still does not recognize some important elements, such as the inclusion of knowledge management as a whole.

Key problems and space for improvement are still to be addressed through future research, for this one did not show that CDICC has relationship with Knowledge storage and dissemination, as well as on Product performance. The reasons for lack of this relationship that are mentioned above should be formally investigated, as well as connection between relationship between Knowledge storage and dissemination, and Product performance. The research of perception of knowledge management as a sum of interrelated processes could give some answers. In addition, attention should be given to elements of cluster relationships, such as cluster resources and relations, because they can create space for cluster's further development, but they first must be resolved at strategical level.

Conclusion

The CDICC research identifies factors that can help enhance relationship between defence cluster and development of new and improved products, as well as with market expansion, the state of CDICC, its current achievements and problems that still need to be resolved.

Based on the importance placed on knowledge management processes and innovation, five hypotheses were proposed, out of which three were confirmed: (1) a relationship between CDICC and Knowledge Creation and Acquisition, showing support for RP1; (2) a relationship between CDICC and Innovation Performance, showing support for RP3; (3) a relationship between CDICC and Market Performance, showing support for RP4.

Previously conducted research by Lai et al (Lai, Hsu, Lin, Chen, & Lin, 2014) proposed and confirmed all four hypotheses which consider influence between cluster, knowledge management and innovation performance; whilst hypotheses in this

article consider a relationship between CDICC and alike matters, with RP3 being the most similar hypotheses in both studies. Their research was conducted on 15176 firms divided in export processing zone, industrial zone and science parks, where most firms fall under industrial zone also employing the biggest number of employees (Lai, Hsu, Lin, Chen, & Lin, 2014: p.736), whilst this research was conducted on 23 firms; divided in private, public, and mixed- and 11 of them all are producing companies. Another research by Chang et al (Chang, Chung & Handerson, 2012) also proposed four hypotheses, which consider how knowledge innovation capability effects business performance, but also explore the role of industrial clusters and regional innovation systems. Two hypotheses were confirmed and two were partially confirmed. The research was conducted on three science-based industrial Taiwanese parks, on 126 IC, Optoelectonics, Precision Machinery and Computer & Accessories firms (Chang, Chung & Handerson, 2012: pp. 12-13. The third research by Lai et al (Lai, Hsu & Lin, 2013) that we can relate our research to, for it is a very narrow field, has seven confirmed hypotheses related to cluster resources and their relationships, correlations or effects with various elements such as cluster relationships, geographic proximity of cluster relationships, resource sharing across supply chain, vertical integration of cluster relationships, cooperation among companies, horizontal competition and company performance. The research was conducted on six Taiwanese clusters (parks) in special economic zone (SEZ), on 266 companies (Lai, Hsu & Lin, 2013: p. 12). Additionally, we emphasize that none of this research included government institutions that have its specifics (especially military), so proper comparison would be very difficult.

The results of this research show that CDICC does bring certain benefits to its member companies. There is space for improvement and further strengthening of cooperation will intensify synergy and competitiveness. On one side, this research showed that CDICC started to achieve some of its goals even in early phase of development. On the other side, it revealed problems that can potentially slow down its development if they are not attained.

The limitation of this paper is the size of the cluster and the ratio of members in different sectors. Future implications could be the potential future research regarding CDICC's relationship with Knowledge storage and dissemination, with Product performance, whilst connection between Knowledge storage and dissemination, and Product performance should be further investigated. The research of perception of knowledge management as a sum of interrelated processes, and elements of cluster relationships should be addressed.

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