An approach to support enterprises during an economic crisis

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Abstract

One of the main reasons for an enterprise to achieve its goals and objectives as a business organization is the ability to avoid risks as much as possible. In an economic crisis enterprises are facing various issues impacting their missions. A way to deal with these issues could be the ability to improve the flexibility and the relevance of collaboration. Thus, enterprises could be able to adapt their collaborations (customers, suppliers, service providers, etc.) in a more reactive way and absorb in an easier way the drawbacks of the faced crisis. So how can we support enterprises in choosing their collaborative partners and how can we optimize this process. In this article we propose an approach that helps enterprises chose their most compatible partner based on the industrial classification "NACE code" as well as KPI classification. Also, a use case from the automotive industry is presented, to illustrate the prediction and selection process for collaborative partners.

Keywords:

Collaborative networks, Risk management, Collaboration detection, Economic crisis.

1 Introduction

Whether public, private, or non-profit, a business serves a market, executes missions, and — presuming all goes well — fulfills the vision that the leaders have set for that business. Throughout the course of operations, business leaders set goals and objectives for their enterprise, and they assign teams to work hard and deliver on them. These goals and objectives are business needs, they are the things the business must have or achieve to run, to be profitable, to serve effectively, and to deliver successfully on its missions.

For an enterprise, these goals and objectives could be increasing its market share, sales, etc... or it could be the ability to resist any crisis that would affect the flow of the business. Nowadays, due to the rapid market change, the fierce competition between enterprises as well as unpredictable outside actions, enterprises face economic crisis that affect their performance and also their existence. As mentioned in [1], risk and opportunity are considered to be the same concept. Based on that, we could claim that seizing an opportunity could be a way to avoid risk. And *one way of seizing opportunities is to find compatible collaborative networks to work within*.

In an economic crisis, enterprises are facing various issues impacting their missions. A way to deal with these issues could be to improve the flexibility and the relevance of collaborations. Thus, enterprises

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could be able to adapt their collaborations (customers, service providers, suppliers, etc.) in a more reactive way and absorb in an easier way the drawbacks of the faced crisis.

So, for an enterprise that wants to seize opportunities in order to avoid risks, it must have a good, strong and trustable relation with its partners whether they are suppliers, providers or customers. However, what if the performance of the enterprise in the market is dependent on the quality of collaboration. Therefore, how can we predict and settle a good collaboration that will affect positively on the market performance of the enterprise which in return will make the enterprise stand on a solid ground against any predicted or unpredicted risks.

In this paper we will propose four steps for enterprises to follow based on NACE code and KPI classification in order to support new collaboration as a way to survive crisis situation because it offer options to adapt to the faced situation and to find new paths to survive.

In section 2, a literature review is presented that discusses types of collaboration networks, collaboration types and KPI classification. Section 3 presents the proposed idea of the four steps as well as an automotive use case to illustrate the approach. Finally, section 4 presents the conclusion.

2 Background

As we are trying to address the question of identifying new collaborative partners in a collaborative network, we are going to study the literature review according to three points. Types of collaboration networks, types of collaboration links, NACE code and KPI classification.

Organizations are always facing new decisions, and while encountering the decision-making processes, they must reach an objective or take a decision after considering potential options to avoid potential risks. The decision-making process increases in complexity when more than one actor is involved in the decision; this occurs in collaborative networks. Camarinha-Matos and Afsarmanesh [2] defines collaborative networks (CN) as a partnership of autonomous organizations and people, supported by a computer network, that collaborate to share resources, such as connectivity and data. The organizations and people may be in different geographic locations as well as from very different professional environments. Enterprises develop collaboration networks with complementary organizations in order to be competitive regarding certain markets, businesses, or scientific innovations.

Collaboration networks pushes the business to new heights. There are now companies that reach out to their network rather than hire an expert to solve a problem [3].

2.1 Types of collaboration networks

Collaborative networks come in many diverse forms and can be quite complex. Due to the availability of IOT tools, artificial intelligence, big data as an example, and as a response to the overwhelming amount of accessible information, these networks have evolved considerably. Some forms of collaboration networks include the following as described in [4] [2] [5] [6]:

- Virtual Organization (VO): This type of network does not have a physical infrastructure. It uses technology to collaborate and is a loose alliance of professionals or companies. It relies heavily on telecommunications.
- Virtual Enterprise (VE): A VE is a special type of a VO. It is a collection of distinct organizations that come together to solve a problem based on their unique skills. There is

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usually basic investment and overhead, and they disappear once they have completed their project.

- Extended Enterprise: A type of VE, an extended enterprise expands their business to fuse suppliers or other partner relations. This creates a dominant enterprise, however, that either purchases or enters into a contract with other entities to provide a service or product.
- VO Breeding Environment (VBE): These types of organizations make themselves available for opportunities. One member chooses which businesses make sense for the project and then contracts them. Upon entry to the VBE, members set up the agreements and infrastructure.
- Professional Virtual Community (PVC): PVCs represent both virtual communities and professional communities. Also, they provide a sense of community for professionals.
- E-Science: This type of network is specific to science, enabling resource sharing between professionals and institutions.
- Virtual Laboratory: This is a of type of E-Science. It assists geographically distributed scientists and researchers in working together and sharing resources, such as tools and information.
- Business Ecosystem: A business ecosystem is the network of businesses that are involved in delivering a service or product. This network can consist of customers, suppliers and regulatory agencies. Somewhat, this ecosystem served as the original network for business collaboration.
- Virtual Manufacturing Network (VMN): Using information and communications technology (ICT), a VMN brings together different partners. The VMN manages the configuration, management, and monitoring of the manufacturing process using technology.

2.2 Types of collaboration links

The authors in [7] proposed a relation between 5 exchange types between enterprises and collaboration links. The relation is between resources that the enterprise owns, information that the enterprise have, intermediate product that the enterprise uses to make their final product, final product that the enterprise sells and is considered as their business activity, services that the enterprise needs or provides and whether they can be sold, received or shared within a collaboration network. These exchange types will be used as collaboration types and they are following:

1. Owner – Renter, 2. Informer/Advisor – Recipient, 3. Supplier – Integrator, 4 Vendor – Customer, 5. Endorsee – Endorser, 6. Provider – Receiver, 7. Co-owners, 8. Co-informers, 9. Co-suppliers, 10. Co-vendors, 11. Co-endorsers, 12. Co-providers

2.3 NACE code and KPI classification

The variety in network benefits, types and limitations creates a difficulty for a company to find new compatible collaborations, and likely the members that it needs to form a collaborative network. To help enterprises form collaboration, an enterprise profile should be defined first. There are a lot of characteristics that can distinguish and define an enterprise. The characteristics of the profile as mentioned in [7] is performance, size, industrial type, type of benefit desired and collaboration capability. Some of these characteristics can be numerically measured like performance, size and industrial type and some are not numerically measured like type of benefit desired and collaboration capability.

A profile for any enterprise can be created by using these five characteristics. This profile can be used in identifying the potential collaboration partner/s within a network. Any subsets of these five characteristics could be a significant way to characterize organizations. In this article we will only

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consider one specific characteristic which is the type of industry (NACE code). This characteristic is incredibly significant to collaboration properties, because the industrial type is related to the business of an enterprise. Also, the data of the other characteristics is not easily available due to lots of obstacles like legal issues. We know that considering only the type of industry is not perfectly accurate for proposing our approach. However, we see that as a start to a more complex and inclusive work that can consider more characteristics for creating such an approach.

In the approach of this research we will use the KPI dimensions mentioned in [7] to infer potential opportunity of collaboration between enterprises and they are as following:

1. Financial (F) - a measurable value that indicates how well a company is doing regarding generating revenue and profits (ex. Liquidity ratio).

2. Resources (R) - measure the efficiency and effectiveness of human resources processes or machinery (ex. Employee Productivity Rate).

3. Knowledge (K) - measurement of an organization knowledge development (ex. R&D expenses).

4. Product (P) - measurement of a product quality (ex. safety and reliability).

5. Market (M) - measurement of product effectiveness on customers and market (ex. customer satisfaction and market share percentage).

2.4 Crisis management

As mentioned in [8], risk can be treated as the mix of the probability of occurrence and the effect of hazard. This is a very classical two dimensions description of risk (probability VS. impact). Also, based on [9] risk can be considered as based on three crucial segments: (i) a danger which initiate the risk; (ii) an event with probability of existing based on the risk; and (iii) a consequence resulted from the happening of the risk. In [10] the authors describe a structure of a dependency chain based on the Danger / Risk / Consequence chain (DRC chain). But [1] extended this structure to include favorable condition that act as positive reflect of danger, and it is shown in fig 1.

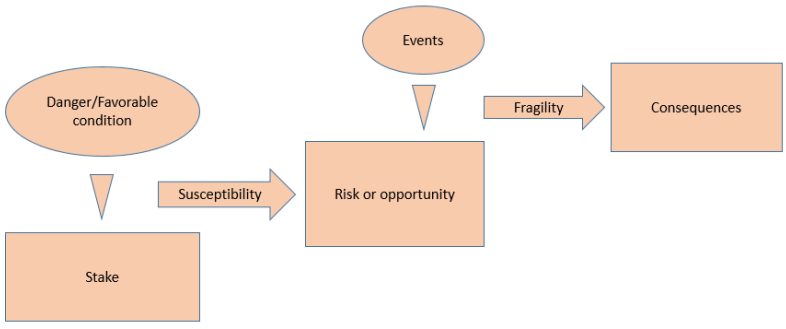

Figure 1. The extended DRC chain as mentioned in [1]

3 Approach and illustrative use case

As stated in the introduction, one way to survive crisis situation is to support new collaboration for enterprises as it offer options to adapt to the faced circumstances and to find new paths to survive.

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Before discussing the four steps, we need to say that we base our approach on the following: We assume that there is a relation between the KPI dimensions, the collaboration type and the industrial classification (NACE code). This relation will have for each industrial code the KPI dimensions that will be affected by a type of collaboration, when an enterprise have a collaboration with such industry. For example, the manufacturing mobile phones industry has a code of "0152". If enterprise X is going to have a collaboration with any industry of code "0152" of a specific type (as mentioned above, like an owner-renter), this collaboration is going to affect enterprise X's KPI dimensions negatively or positively. Thus, this will be a big database that contains all possible collaboration type effects on KPI dimensions for all industrial classifications. After that comes the four steps approach that will help enterprises detect the best collaborative partner.

The **first step** in our approach is to identify which KPI dimension/s the company wants to improve. The **second step** is to determine which industries and collaboration types are affected by the KPI dimensions chosen in the first step. The **third step** is comparing and filtering out the industries and their corresponding collaboration types with the KPI dimensions identified in step one. The **fourth and last step** is to decide which industry is better for collaboration using for example multi criteria decision making process. This will be clearly explained and illustrated in the use case presented in the next sub-section.

Use case

Due to the Covid-19 circumstances, one of the main industrial sectors that were highly affected is the automotive sector. In this section we are going to present a fake use case that illustrates the approach we discussed earlier. Company X is a well-known car manufacturer (NACE Code 29) located in Japan which has more than 65000 employees around the world and about $755 million as its capital. We will consider company X as the manufacturer which deals with its supplier to buy raw materials. They then produce the cars using these materials. Then gives the products to the dealer who distributes them to the retailer who finally gives them to the consumer.

Moreover, we can specify the types of activities of company X into 4. First activity type is with suppliers. Second activity type is with customers/dealers. Third activity type is with any company whether a competitor or any other type of company that can provide any kind of service to company X. Fourth activity type is with any other company that can share information and knowledge to help improve quality, sales or even act as one company to sell the same product to customers.

Company X's main activity is to assemble parts of the car that are purchased from sub-contractors or suppliers. 75% of these sub-contractors or suppliers are located in Japan and 25% are located all around the world between America, Europe and Asia. Another activity for company X is getting into projects with other companies or subsidiaries to produce a new product. The projects that the company can be involved in manufacturing working vehicles like trucks and diesel engines which requires more powerful industrial machinery. Another project can be participating with another company to produce and develop electric vehicles which requires a new technology. Another project for company X is manufacturing compact vehicles and bikes which requires a different production line other than the production line of normal cars. Another type of partnership for company X is to provide services for its customers like repair and yearly check-ups for the cars as well as receiving services from other companies. Also, the sales of spare parts to customers or repair centers.

Company X can receive information from a company that provides consultancy services for example or can receive any other form of service from any other company. Company X can buy raw materials

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or receive a service or even receive information from suppliers. Company X can share information with a competitor or act as endorser for another company in a new market or be an endorsee to a competitor. Company X can sell finished products or provide a service like check-ups to the customer. We can model the types of collaboration for company X as seen in fig 2.

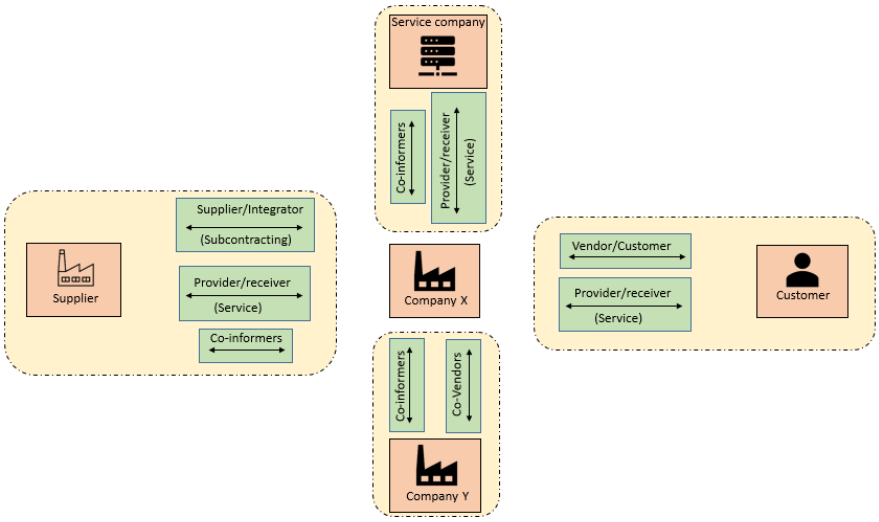

Figure 2. Relationship between company X and four types of entity

As seen in fig 2, company X has 9 types of collaboration with four different types of entities, customers, suppliers, service providers, and other companies (competitors or other).

The type of collaborations that company X interacts with a customer is:

- Vendor/Customer – Customer buys finished product (car) from vendor (Company X or retailer that is related to Company X)

- Provider/Receiver (provide service) – Customer receives service from company X like routine check-ups.

The type of collaborations that company X interacts with a supplier is:

- Supplier/Integrator (sub-contracting) – Supplier provides Company X with intermediate products used for car manufacturing.

- Provider/Receiver (provide service) – Supplier provides Company X with services used for car manufacturing.

- Co-informers (ex. share information for new technology) – Supplier provides Company X with information used for car manufacturing.

The type of collaborations that company X interacts with a service provider is:

- Provider/Receiver (provide service) – Service provider provides Company X with services used for car manufacturing or any other domain.
- Co-informers (share information for new technology) – Service provider provides information for Company X used for car manufacturing or any other domain.

The type of collaborations that company X interacts with other companies in the same industrial code (competitors) is:

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- Co-vendors (subsidiary) – Company X will act as endorsee, endorser or subsidiary to another company (competitor) to sell finished products (cars).

- Co-informers (ex. share information for new technology) – Company X receives or gives information with another company (competitor) used for car manufacturing or any other domain.

Every time normal gasoline is pumped into a car, this slightly depletes the world's supply of fossil fuels. These fuels, which include petroleum and coal, are the condensed remains of living organisms from prehistoric times. The supply of these fuels is limited and will eventually expire. Also, much of this supply of petroleum is controlled by a few nations blessed with an abundance of oil and these nations can "influence" both the petroleum supply and its price. Surely, this is not the case, but this can be considered as a theoretical factor. Fossil fuels have met much of the world's energy needs for several centuries, but there is a limit to how long they can continue to do so in the future. Thus, since few years back the renewable energy became a subject for research in order to optimize the use of such ideas and produce vehicles that uses renewable resources instead of normal petroleum. According to [11], hydrogen gas can be one of the future energy sources that we can depend on for cars for a lot of reasons.

Company X wants to create a car engine that uses hydrogen gas as fuel and the same time has the same performance of oil and petroleum engines regarding distance and time. For this objective, company X wants to improve its knowledge about hydrogen engine manufacturing which in return affects the *knowledge KPIs* of our model.

Step 1. Determine which KPI the company wants to improve

In order to manufacture the hydrogen fuel engine, there should be a special kind of technology to do this. For such technology to exist, there should be a certain knowledge which Company X already have or would import for outside. Thus, the desired KPI that has a direct relationship with manufacturing hydrogen fuel engines is the knowledge KPI.

Step 2. Determine all industrial codes and their collaboration types that are affected by the KPIs identified in step 1

In this step all industrial potential partners and their collaboration types for industrial code 29 that are affected by the Knowledge KPI from the periodic table of industrial types are determined and they are following.

Table 1. All possible collaborations for company X

Industrial codes	Collaboration types	KPI
28	2,6	F,K,M
29	1,2,3,4,5,6	F,K,M,R,P
30	2	K
45	1,2,3,4,5,6	F,K,M,R,P
61	2,4,6	F,K,M
63	6	F,K

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70	6	F,K,M,R,P
72	6	F,K
85	2,6	F,K

Step 3. Compare and filter out the industries and their corresponding collaboration types with the KPI dimensions identified in step 1.

In this step we compare the KPI effect of each collaboration type to the desired KPI decided by company X which is improving the knowledge KPI (K).

Table 2. Comparison between KPI effect of each collaboration type and the desired KPI

Collaboration type	KPI affect	KPI desired
1 (Resource)	F-, R+	K+
2 (Information)	F-, K+	
3 (Intermediate product)	F-, P+	
4 (Final product)	F-, P+	
5 (Endorsee)	F-, P+	
6 (Service)	F-, R+, P+, K+, M+	

As seen in Table 2, there are two collaboration types that are concerned with improving the knowledge KPI. As a reason to that, we are concerned about collaboration type's number 2 and 6 as they are the only collaboration types that have an influence on the knowledge KPI (K). Also, we can add another two collaboration types regarding the sharing types which are co-informers for information and co-providers for services. So, at the end we have four collaboration types that we are concerned about for company X which influences the knowledge KPI and they are as following: Informer/Advisor – recipient, Provider – receiver, Co-informers, Co-providers.

As seen in Table 1, not all collaboration contexts can be considered as a direct improvement for the knowledge KPI between company X and the selected industrial codes taking into consideration the need for improving the knowledge to manufacture an engine that uses hydrogen gas as fuel. Thus, we will have to filter out the unrelated industrial codes and the remaining industrial codes that are related to the main objective (improving the knowledge KPI in order to create an engine that uses hydrogen as fuel) are as following:

Table 3. Remaining industrial codes that has a direct relation with improving Knowledge KPI

Industrial codes	Collaboration types	KPI
28	2,6	F,K,M
30	2	K
72	6	F,K

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85	2,6	F,K

Step 4. Decision making process

The last step would be to decide which industrial code is best for company X to collaborate with. To do that there should be a justification for each industrial code and why collaborating with such an industrial code would contribute to the influence in improving the knowledge for the manufacture of the hydrogen fuel engine. This justification is presented in the Table 4 below.

Table 4. Justification for the filtered industrial codes

Industrial code	Collaboration Benefit
28	Industrial code 28 is a good candidate for collaboration as its companies have good information for the manufacture of gas turbines which is what company X wants. Companies in industrial code 28 can either sell this information of manufacturing hydrogen fuel engine to company X, perform a service to company X (outsourcing), or participate in a project together to share such information.
30	Industrial code 30 is a good candidate for collaboration as its companies have good information and experience in manufacturing engines that are used in missiles for space journeys and exploration. Companies in industrial code 28 can either sell this information of manufacturing hydrogen fuel engine to company X, perform a service to company X (outsourcing), or participate in a project together to share such information.
72	Industrial code 72 is a good candidate for collaboration as its organizations have good information and practical experience in research fields. This information can be used to create a research project to manufacture the hydrogen fuel engine, and this would either be sold to company X as information, performed as a service (outsourcing) or shared in a project between company X and a research center.
85	Industrial code 85 is a good candidate for collaboration as its organizations have good information and theoretical experience in research fields. This information can be used to create a research project to manufacture the hydrogen fuel engine. Also, educational centers could have new ideas for improving the hydrogen engine like efficiency, and this would either be sold to company X as information, performed as a service (outsourcing) or shared in a project between company X and a research center.

Of course, there are external factors that can influence the decision-making process, like choosing an industrial code to collaborate with because it will increase company X's market reputation.

Based on the justifications mentioned in Table 4 and other criteria, the decision maker would be able to choose which industrial code is most appropriate to collaborate with. For example, in this case Company X wants to collaborate with an industrial code that has a previous experience in using gas fuel engines and also has minimum percentage of accidents that can occur. The decision maker can choose industrial code 30 (Manufacture of other transport equipment) due to the practical experience and good technical information in manufacturing engines for missiles that perform long journeys in space and has a really small percentage of potential accidents.

4 Conclusion

In this paper a literature review for collaboration network types and KPI classifications were presented. An approach using four steps was presented to help enterprises detect potential partners as a way to

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support enterprises to avoid the drawbacks of risks. Also, an illustrative use case was presented that explained the way these four steps are used.

The next step of this research is to use this concept to build a semi-automatic model that inputs information of an enterprise and outputs a list of suggested potential collaboration partners. This model's concept is to integrate the concepts suggested in this article with the concept and model described in [7] to create a table that imitates the periodic table of elements (Mendeleev table). This table will have industrial types that are classified into columns and rows. Each group and row will have a specific characteristic to define all the industrial classes which will enable by previous experiences to suggest potential collaboration partnerships. This model can help in providing enterprises with a tool that could allow them to detect potential collaborations that could save them and save the economy. That would be a way to stop/reduce opposing health and economy for instance. Also, this would be a massive path to a societal resilience. As it is well known today, a lot of employees around the world are threatened to lose their jobs because of the health crisis that effected the global economy. If this model would exist, it will definitely help in reducing the negative effect of this crisis resulting in saving a lot enterprises from vanishing.

The main challenge for building this model would be gathering a lot of data of previous and current collaboration examples that will help in using, developing and updating the concept of experience in creating and classifying the periodic table of industrial types.

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