The application of a Quality Function Deployment approach for the design of a B2B web platform

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Abstract: Digitization, dematerialization, technological innovation are some of the elements that characterize the levers for being competitive on modern markets. The European and Italian entrepreneurial fabric, strongly characterized by micro and small enterprises and craft businesses, still requires great efforts to make the best use of the enabling technologies of industry 4.0. Within this scenario has been developed the SUPER Craft project. Financed by the Emilia-Romagna Region, the initiative aims to develop a digital Business to Business (B2B) platform for the development of new commercial collaborations between Small and Medium-sized Enterprises (SMEs) and craftsmen, creating a favourable environment for sharing online tools and services for the use of emerging technologies enabling product innovation in the field of advanced design and digital craftsmanship. This paper describes the methodology used to define the main functions of the B2B platform. Participatory co-design was the approach adopted, while the House of Quality (HoQ) was the tool used to combine three main relevant factors: the customer expectations, the platform developer technical needs and the characteristics of other competing platforms already on the market. The results identified in the "system for managing orders" and "systems to speed up processes" the priority technical specifications of the platform that can make this tool useful and competitive for the reference market.

Keywords: Business to Business, House of Quality, Clients' needs, Co-design approach

1. Introduction

The European entrepreneurial fabric and, in particular, the Italian one are characterized by a predominant presence of SMEs (up to 49 employees) and artisan enterprises. In Italy they are 99.4% of the entire national production structure (CNA, 2018). This is an extremely articulated context, rich in ancient production tradition, but at the same time strongly pervaded by creativity and driven by continuous innovation. The markets are in continuous and rapid evolution, moving from systems characterized by a few products with high unit volumes to contexts with many custom items in low volumes. These changes require a high adaptability of manufacturers to modify their processes and market approaches in favor of technology, computerization and innovation. This strong push towards the digitalization and dematerialization of processes (including production) determines the need to develop new business models, innovate products and evolve processes.

The enabling technologies that characterize the fourth industrial revolution offer an important opportunity to encourage innovation in the entire production sector and to make small manufacturing companies and SMEs more flexible and competitive on the market. These tools are well suited to foster an entrepreneurial fabric with a strong artisan prevalence, enhancing some of its typical properties: creativity, high customization capacity, high specialization and a typical direct producer-customer relationship.

Despite the interest and willingness of entrepreneurs to innovate through enabling technologies, many manufacturing companies still produce low-tech processes and products. In fact, even if SMEs and craftsmen represent an extremely suitable environment to innovate their processes, the scarce financial resources, the long return on investment and the need to requalify human capital, constitute significant barriers to entry (Torn and Vaneker, 2019) As described by Dassisti et al. (2019) and Schmitt et al. (2019), this condition is influenced by "the lack of formalized processes, lack of ICT knowledge as well as low-cost commercial systems". Currently, the highest adoption rates by SMEs are found in the less expensive and, therefore, less revolutionary industry 4.0 solutions.

To overcome these critical issues, new business strategies and development philosophies are needed to remain competitive on the markets and to take the opportunities offered by the new enabling technologies. In particular, the 'Portfolio of Relationship' has assumed a dominant role in strategic business management, where the possession of a network of skills (internal and, above all, external to the company) expresses real market power (De Toni and Panizzolo, 2018). Thus, it is essential to know how to identify and/or develop a network capable of

enclosing all the necessary skills. Digital B2B platforms represent an ideal tool for this purpose, which is also a low cost solution for companies.

1.1 The B2B sector

The B2B sector, which is intended for the commerce between businesses, is a market where businesses operate both as sellers and as buyers (Pedersen et al., 2019). It favors the development of commercial relations between economic actors and also represents an ideal environment where to develop synergies and collaborations, as well as in the sharing of resources.

The web offers a dynamic and solid location for B2B interactions, where companies can discover products and services and lay the foundations for future transactions. This will promote a series of important changes in business habits: from the accessibility of new channels without time and geographical position limits to the unlimited availability of information and relationships.

To date, numerous digital tools are available to support the digital B2B sector. According to the Italian 'Digital Innovation' observatory, there are approximately 300 cloud platforms available worldwide. Seven of these are based in Italy. Most of these platforms are dedicated to e-commerce. To the best of our knowledge, we have identified only one platform that partially adapts to the needs of developing "Portfolio of Relationship" between SMEs and small artisans in the use of enabling technologies typical of industry 4.0.

1.2 Objective of work

In the context described above, the SUPER Craft - Smart Utility Platform for Emilia Romagna Craft project is being implemented. This initiative was launched in 2019 and will end in 2021.

SUPER Craft is an industrial research project approved as part of the 'Call for strategic industrial research projects aimed at the priority areas of the smart specialisation strategy' (DGR 986/2018) within the POR-FESR EMILIA ROMAGNA 2014-2020, Axis 1 - Research and innovation, Action 1.2.2. The focus of the SUPER Craft project is the creation of an innovative online B2B platform aimed at the paradigm of 'Continuous Mass Customisation', as opposed to that of discreet 'Mass Customisation'. SUPER Craft offers an integrated approach to innovation in the artisanal and manufacturing sector with transversal application prospects, capable of providing online tools and services for the use of emerging and enabling technologies for product innovation in the field of advanced design and digital crafts. SUPER Craft intends to act on the production process, integrating industrial/technological processes with artisan/creative ones. By developing enabling solutions and a technological platform for continuous interaction between all stakeholders, the project intends to promote a product customisation process that involves all of the conception, design, and production processes through additive manufacturing technologies and intelligent components with a shelf innovation approach. This project and its B2B platform have the goal of encouraging the development and territorial diffusion of the so-called 'network of expertise' necessary for the co-creation of skills, which represents the competitive value of the 'Portfolio of Relationship' philosophy.

This paper describes the results of the approach used to define the main functions of the SUPER Craft B2B platform. A participatory approach was applied, directly involving some SMEs from the Emilia-Romagna region. The collected data were processed through the House of Quality (HoQ) tool (Section 2) which allowed to combine three main relevant factors: the customer expectations, the platform developer technical needs and the characteristics of other competing platforms already on the market. The results identified the priority technical specifications of the platform which can make this tool useful and competitive for the reference market.

2. Operational approach

Designing the structure of a B2B platform for the purposes of the project includes starting complex strategic activities that must then be integrated into daily business life. It is necessary to know how to combine different elements during the design of a successful tool. In particular, these include the users' needs and preferences, customer experience, technical and economic constraints and main characteristics of international competitors.

Quality Function Deployment (QFD) is a methodology that supports the design of a product/services through correlation matrices capable of combining the client's requests and the technical characteristics that can be used to satisfy them. The result is a system engineering process that prioritises and links the product development process to ensure product quality as defined by the customer/user (Shahin, 2008). Operatively, QFD applies a four-phase approach (Figure 1), where the output of one step is the input of the next one.

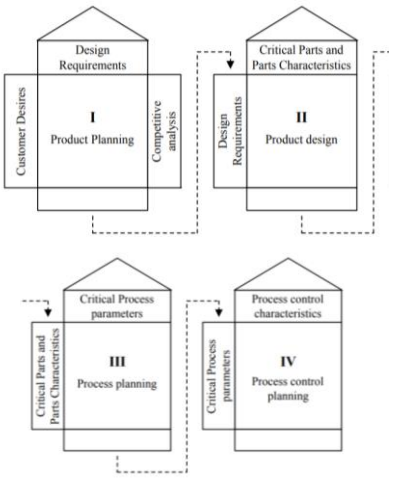

Figure 1. Phases of QFD (Cohen, 1995)

Each of the four phases operates through the House of Quality (HoQ) (Figure 2). HoQ combines the needs of users with technical aspects to define the characteristic priorities of the product/service to be effective on the market. Its compilation takes place in the following stages (Shahin, 2008):

1. Identify what the customers want (WHATS).
2. Conduct a customer market evaluation, in order to confront the best.
3. List the technical specifications (HOWS).
4. Assess the correlation matrix between 'HOW' items.
5. Highlight the relationships between WHATS and HOWS.
6. Assess the difficulty of the technical 'HOWS' items.

In this study, the QFD was applied through the use of the Product Planning Matrix (the first matrix of figure 1).

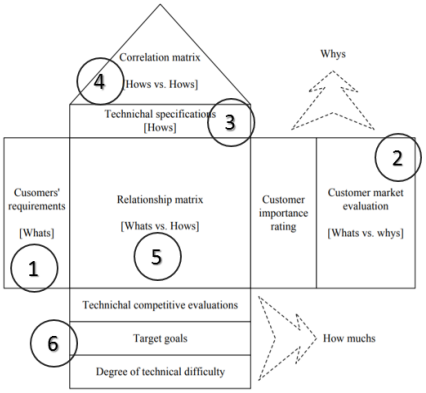

Figure 2. House of quality (HoQ)

This approach is a widely used technique when innovative products must maximize customer satisfaction and offers support to designers in determining the most relevant technical characteristics during the design and development process (Chan and Wu, 2002). In particular, as analyzed by Erdil and Arani (2018), this tool is mainly used for the design and development of new products (80% of the cases analyzed by the authors) and, to a lesser extent, for their implementation.

In fact, with its numerous variations and the numerous operating models that characterize it, the QFD represents an approach widely spread and discussed in the literature. In particular, the theme of the design of specific products and services for e-business is highly studied. Barutcu (2006) applies the HoQ to design a digital platform for online business activities, involving numerous users through a participatory approach. Applications to similar products have been discussed by Chou (2020), Tan et al. (2007) and Shaikh et al. (2001), with particular reference to the importance of online business platforms for SMEs and the information they communicate.

Luo et al. (2008) analyzes the B2B sector, but also evaluating the aspect of product customization and, therefore, of direct customer-supplier interaction. Similarly, Germani et al. (2012) analyzes the issue of efficient collaborative product design through dedicated platforms. Sousa (2015) analyzes through the QFD the definition of the service channels to be used to support delivery to customers.

Finally, Wang et al. (2020) analyze a collaborative supply chain design of large complex products.

3. Case study

In the development of the B2B platform, the reference case study examined is the territory of the Emilia-Romagna Region (Italy), which is a large industrial centre with a large number of artisans and SMEs. The regional entrepreneurial fabric has these characteristics:

- There are a large number of micro and small size actors.

- There is high competition and a continuous need for evolution dictated by the market.

- Competitiveness requires continuous research and technological innovation.

- Specialist skills are required.

- There are few investment opportunities.

- There is a need to develop better synergies between companies to share knowledge and skills for the creation of common value.

The collaborative approach for the study and identification of the platform's prevalent functions was conducted through the direct involvement of some regional SMEs. Regional companies belonging to different product sectors have been selected (Figures 3), capable of representing the diversity of the local production sector. Have been involved mainly SMEs and craftsmen (less than 50 employees) and, to a small extent, large companies (up to 8,500 employees) (Figures 4). Overall, 58 SMEs and craftsmen were involved. Figure 5 highlights their spatial distribution over the regional territory.

The involvement was guaranteed through an on-line questionnaire and dedicated surveys. The primary objective of the involvement was to identify the characteristics of the platform considered most relevant for users. The questionnaire was structured through 5 categories (Dorn et al., 2009), representative of the main features of the platform. In particular:

1. Usability: this is the effectiveness and speed with which users can perform activities in a particular environment of a product in a satisfactory way.
2. Reliability: this indicates the ability of the system to respect and satisfy its technical specifications and function over time.
3. Security: this indicates the system's ability to be secure, protected from external attacks that can cause the loss or modification of confidential data.
4. Friendly: this expresses how easy the system is to understand and use, especially for people who are not experts.
5. Other needs.

For each category, several questions were requested. For each question it was asked to indicate the relative level of

importance, using a score scale between 1 and 5 (1: not important; 5: very important).

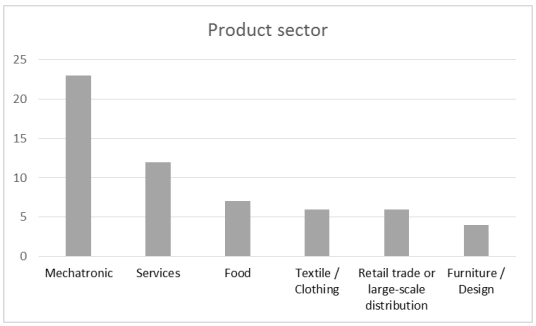

Figure 3. Product sector of the companies involved

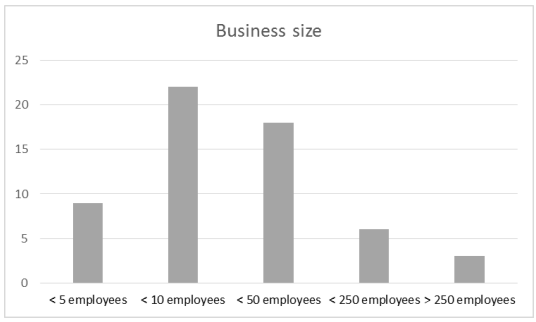

Figure 4. Size of the companies involved

Figure 5. Spatial distribution on the regional territory

4. Results

The characteristic steps of HoQ development have been implemented. The results obtained are shown in Figure 6, which graphically represents the HoQ as a whole. This allows to appreciate the entire process of applying the tool, being able to immediately identify its main result: the final rating of the HOWS compared to the WHATS.

The individual phases that led to its development are detailed below.

4.1 Identify what customer wants

By applying the same categories used in the questionnaires, customers' needs were classified into five classes. For each class, the main reference WHATS have been identified, as shown in Table 1.

For each WHAT, customers have assigned a score (using a quantitative value between 1 and 5 as shown in Table 2) which expresses their relative importance recognized to each one. The value entered in the HoQ of the Figure 6 is the median of the scores assigned by the 58 interviewees. Finally, the relative importance was calculated as the ratio of the value of each WHAT to the sum of the scores assigned to all the WHATS considered.

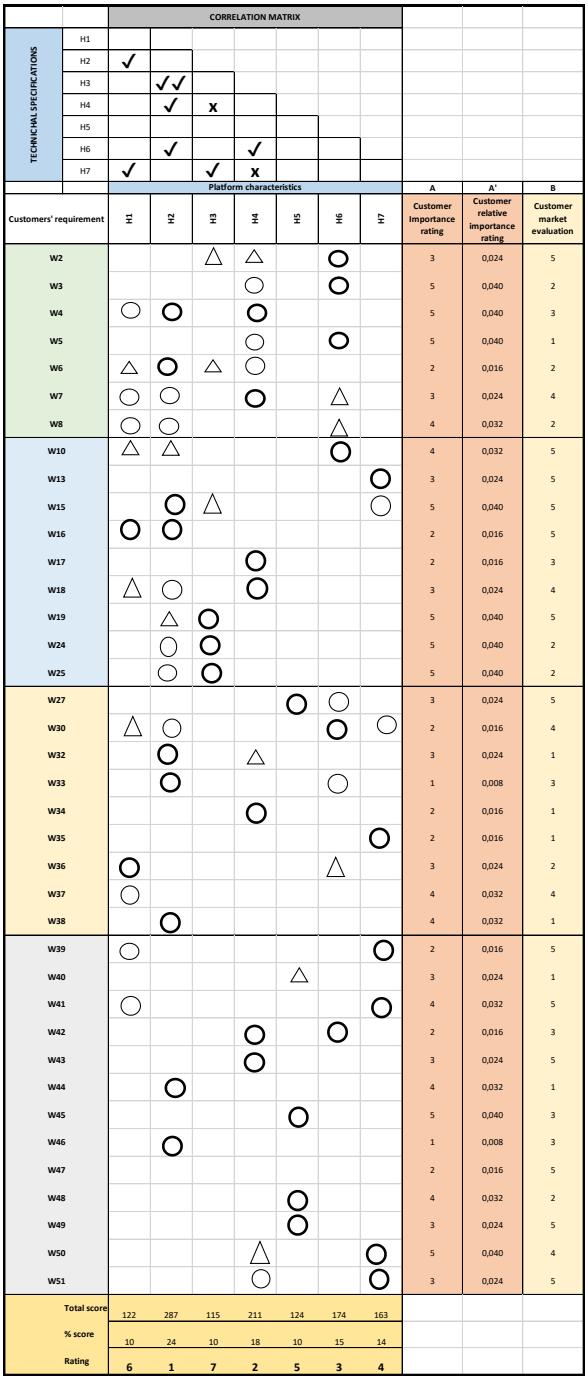

Figure 6. House of quality of B2B platform under study

Table 1. WHATS list

Usability
W1 How easy it is to find a website using the search engine
W2 Simple and efficient registration
W3 Easy insertion of the design into the platform
W4 Possibility and ease of changing the order
W5 Simple, easy to use transaction process
W6 Rapidity in placing orders
W7 Fast response to orders

W8 Easy cancellation of orders
W9 Loading speed
Reliability
W10 Provides a personalised service that includes personalised pages, saved browser history, and saved purchase history
W11 Comfortable and easy to use website operation
W12 Easy verification of service information
W13 Economic quality guarantee
W14 Precise payment amount
W15 Ability to interact with an employee
W16 Provides assistance when users have problems
W17 Timely responses to all support questions
W18 Provides timely service
Security
W19 Payment security
W20 Ability to pay cash on delivery
W21 Ability to pay by credit card online
W22 Ability to pay through a third-party payment platform
W23 Provides a regular purchase receipt
W24 Guarantees privacy
W25 Data and project security
Friendly
W26 Favourable and appreciable website image
W27 Abundant service information
W28 Customer service support also in English
W29 Accurate and credible service information
W30 Updated product information
W31 High cost-performance ratio
W32 Variety of distribution methods
W33 Order information updated in real time
W34 Fast delivery
W35 Adequate product development times
W36 Ease of contacting the supplier
W37 Positive attitude of staff
W38 Possibility of returning, replacing, or modifying product
Other needs
W39 Need to create complex products with more functionality
W40 Looking for the best price
W41 Desire to evaluate multiple ways of carrying out the project
W42 Quick and easy to use system
W43 Reduction of overhead costs
W44 Simplified transport and delivery system
W45 Increase in revenue
W46 Increase in the efficiency of the ordering process and decrease in order errors
W47 Test yourself and broaden your knowledge
W48 Sell at a good price
W49 Widen the circle of customers
W50 Satisfy the end customer
W51 Create a lasting relationship with the customer

Table 2. Quantitative score scale

Score	Description
1	Very unimportant
2	Not very important
3	Important
4	Very important
5	Most important

4.2 Customer market evaluation

The level of competition for the B2B platform object of the project appeared to be limited. Only one possible competitor has been identified on the market and therefore used as the benchmark. Similar to what was done in relation to the previous point (3.1), the same scores were assigned by the 58 respondents to each WHAT with respect to the competing product in order to determine the target audience to consider.

4.3 Technical specifications (HOWS)

In identifying the HOWS, the skills of the project partners involved in the technological development of the platform have been considered. Through meetings and questionnaires, several HOWS were identified, as listed below:

- H1 Direct communication with project manager
- H2 System for managing orders
- H3 Security systems
- H4 Systems to speed up processes
- H5 Advertising systems
- H6 Graphics and user-friendly system
- H7 Product quality control systems

4.4 Correlation matrix

Possible correlations between the different HOWS could be identified and these can be positive or negative. A very strong positive correlation was identified between H2 and H3. This means that the modification of one characteristic determines a modification of the other in the same direction. Negative correlations were assigned to combinations H3-H4 and H4-H7. The modification of one characteristic determines a modification of the other in the opposite direction.

Table 3. Correlation matrix legend

Symbol	Description
✓ ✓	Strong positive impact
✓	Moderate positive impact
[blank space]	No impact
X	Moderate negative impact
XX	Strong negative impact

4.5 Relationship matrix

In this phase, the relationships between the customer's needs and the technical-engineering characteristics were established. The independent scoring method was applied (Franceschini et al., 2014). This is a classic method whose primary objective is to create a hierarchy for the technical characteristics of the service in question. The ordering of the technical characteristics is fundamental for a QFD analysis, through which companies shift their attention towards quality from the production process to the design, with the goal of designing the product starting from the needs of the customer. The independent scoring method involves the following operational steps.

1. Assign a relationship score and numerical value using a conventional scale: 1-3-9 or 1-5-9 (Franceschini et al., 2014). The 1-5-9 scale was used in the present work. The relations and scores are listed in Table 4.

Table 4. Relationship matrix legend

Relation	Scale	Symbol
No relationship	0	[blank space]
Weak relationship	1	△
Mean relationship	5	○
Strong relationship	9	◎

2. The second step determines the level of importance of each WHAT given by the products between the relative importance of the WHAT and the scale value that binds it to each HOW. Figure 6 shows an example for seven WHATS.

Customers' requirement	H1	H2	H3	H4	H5	H6	H7
W2	0	0	2	2	0	21	0
W3	0	0	0	20	0	36	0
W4	20	36	0	36	0	0	0
W5	0	0	0	20	0	36	0
W6	2	14	2	8	0	0	0
W7	12	12	0	21	0	2	0
W8	16	16	0	0	0	3	0

Figure 6. Some results of relationship matrix

4.6 Technical assessment

The absolute and relative indices of the importance of the technical characteristic are reported at the bottoms of the various columns, which were calculated as the sums of the values of each column of the relationship matrix. In this way, the ranking was determined, and the most relevant technical specifications for customer satisfaction were highlighted (Figure 7). This demonstrated the HOWS that have the greatest relevance in the definition of the product. In the case study, H2, H4, and H6 were the most relevant, while H3 and H1 were the least relevant.

Customers' requirement	H1	H2	H3	H4	H5	H6	H7
Rating	6	1	7	2	5	3	4

Figure 7. HOWS ranking

4.7 Improvement of independent scoring method

The approach adopted in point 3.6 is an example of an independent scoring method, that is an arbitrary method. This approach can be improved through other classification strategies. The Lyman method (Layman, 1990) normalizes the coefficients of the relationship matrix, with respect to the sum of the values of each row of WHATS. To be able to take into account any degrees of correlation between the technical characteristics (shown on the roof of the HoQ), the Wassermann method can be applied (Wassermann, 1993). Figure 8 shows the results obtained on the rating, using these two methods.

Customers' requirement	H1	H2	H3	H4	H5	H6	H7
Rating Layman normalisation	6	1	7	2	3	5	4
Rating Wassermann normalisation	6	1	4	2	3	5	7

Figure 8. HOWS rating after Layman normalisation (top) e Wassermann normalisation (below)

5. Discussion and conclusions

QFD, through HoQ tool, is an approach that ensures the quality of a product from the early stages of its design to its realisation, placing customer satisfaction as the basis of this process in relation to the requirements that the final product or service must meet. The extensive literature available on the use of these tools for the development and implementation of products and services, expresses their high operational potential and the ability to adapt to heterogeneous contexts and systems. The structure for applying the HoQ is rather standardized in the approaches and type of data needed. The quantitative values used in the relationship matrix and the mathematical approaches of classification of priorities are subject of continuous improvements.

The application of the methodological approach allowed the authors to test each step and to provide the following comments and observations. I) Conceptualizing a B2B platform for such fragmented, small and artisan realities which form the regional production fabric, providing a multitude of functionalities and possible services requires a very significant effort. This was represented through 51 overall WHATS. To overcome this difficulty, WHATS have been classified into homogeneous groups. II) The same criticality also characterized the co-design process represented by the HoQ approach. There are over 400,000 SMEs on the study area. Their involvement took place through the selection of a representative sample of some production sectors. It is important to underline how the Covid-19 emergency did not contribute to this phase. III) With the collected questionnaires, the importance recognized by customers for each WHAT was analyzed. The scores assigned showed a rather homogeneous distribution. The most frequent scores were 3 (29%) and 5 (26%). IV) Having identified only one competitor on the market, the comparison was important, but applications with multiple references lead to more representative results. V) HOWS represent characteristic elements of a digital platform which must guarantee easy use, adequate quality and safety and opportunities for personal communication between operators. Direct correlation was found for most of these functions.

Finally, it was observed that, by changing the WHATS and HOWS combination approach, also the final ranking also changes its order. Each proposed approach presented a different hierarchical distribution of the alternatives. However, there were some common results. In particular, HOW n.2 and n.4 were always the best, whereas n.3 and n.1 were the least important for the development of the platform. This means that in the development of the platform, particular attention must be paid to order management, making the process quick. Security systems and direct contact with project managers are less relevant..

In conclusion, the use of the HoQ has proved useful for the design of a digital B2B platform aimed at supporting SMEs in creating a 'Portfolio of Relationship'. The results obtained have shown how the co-design process can be supported by dedicated tools, such as HoQ. These have been computerized within the platform currently under development. This approach, also through its experimental application to the case study described, has highlighted some strengths (ability to manage a plurality of needs of users and product developers, combining them and comparing them with other competitors) and some weaknesses (subjective human cognition in quantifying WHATS and the high sensitivity to the scoring method

used for the technical assessment), which is also confirmed by other experiences in the literature. Since the B2B platform is the core of the project and this study represents its scientific basis, the strengths and weaknesses have been appropriately considered as the possible risk factors. The platform will be operational in an experimental form shortly and, through the activation of the SMEs involved in the project, it will be possible to verify its operational performance, also detecting the effectiveness of the results obtained with the HoQ described here.

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