

Organizational Agility Assessment of a Moroccan Healthcare Organization in Times of COVID-19

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ABSTRACT

Since its appearance, COVID-19 has severely impacted the healthcare sector all over the world. The healthcare organizations should be agile in order to cope with this new health crisis. Indeed, organization agility was highly recommended as an essential basis for flexibility, innovation, speed, as well competitiveness. Different research provided different conceptual models suitable to evaluate the organization agility. In this sense, this paper presents an assessment model, which by defining different agile enablers, criteria and attributes, aims at identifying the least and the most suitable enablers influencing the healthcare organization agility. To realize it practically, this paper uses the fuzzy logic approach which provides the improvement directions for enhancing the organization agility. Subsequently, the data gathered from a Moroccan healthcare organization was substituted in this assessment model and the level and the suggestions improvement for agility were derived. In this way, the organization will integrate the successful combination of the agility enablers in this dynamic environment.

1. Introduction

The story of the pandemic “COVID-19” began in 2019 when the first case were identified from Wuhan, China [1]. Since its first appearance, COVID-19 has been receiving an increasing attention by academic and executive specialists and many researches have been developed on it in order to provide a general definition of the virus. In the beginning, COVID-19 has created a global healthcare crisis, and then it disrupted other sectors: economic, environmental and social [2]. But perhaps the most significant pressure was for the healthcare organizations which strengthened their medical system [3] in order to enhance their responsiveness, adaptability, flexibility, which explains the importance of agility implementation in the healthcare sector through the outbreaks of COVID 19.

Agility concept was presented as the effective exploration of different competitive bases by including the suitable resources and practices in order to cope with the changing environment [4, 5]. Later, different proposals of agility definitions have been derived and which presented a general consensus [5]: It means the organization capacity to react quickly [5]–[11] to the varied changes in market demand [8]–[11] in terms of cost, specification, quality, quantity and delivery [11, 12]. Despite being defined in different ways and from different perspectives, agility has sometimes been used interchangeably to refer to concepts such as

adaptability, flexibility, speed, intelligence or sharpness. In contrast to this point of view, several authors have expressed the difference between these concepts, which justifies our choice to use the word "Agility" many times in our paper.

In order to evaluate the agility of an organization [5], several approaches such as system approach [5, 13], graph theory [5, 14], multi-grade fuzzy logic [15], regression analysis [5, 16] and other artificial intelligence techniques, such as neural network [15], neuro-fuzzy [15], have been used [5, 13, 14, 16–19]. A main objective of this study is to help the healthcare organization to implement an easier and less complicated practical tool in order to evaluate their agility [11]. The above purpose suggests an assessment model in which we evaluated the enablers influencing the adoption of agility [15].

Our paper is organized as follows: In the next paragraph, we review previous researches related to agile enablers. By presenting the fuzzy logic approach, we presented the required steps to apply this methodology to a real case. Moreover, the results provided are discussed and the limits of the study and suggestions for future research are finally presented [11].

2. Literature review: Agile enablers

According to different conceptual models of agility presented in literature, companies can benefit from different enablers [11] in order to achieve agility. These enablers, also known as providers

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or levers [20], were introduced by Gunasekaran [21, 22] in order to identify the required features of the agile organization [20]. In his study, he identified seven agile enablers: virtual corporation formation tools/metrics, physically distributed teams and manufacturing, quick partnership formation, concurrent engineering, integrated information system, quick prototyping tools and E-commerce [22]. In 1999, Yusuf et al. [4] presented different enablers under ten groups: the introduction of new products, the formation of partnerships, continuous improvement, short conception/production of deadlines, decentralized decision-making, response to market requirements ...etc [20]. Later, Sharifi and his colleagues proposed four enablers from four different areas: organization, people, technology and innovation [9, 23]. Based on their sample, Tolf et al. identified five essentials enablers for an agile organization: transparent and transient inter-organizational links at all levels, market sensitivity and customer focus, management by support for self-organizing employees, organic structures and flexible human and resource capacity for timely delivery [24]. In their paper [25], Lin and his colleagues suggested four agility enablers: collaborative relationships, process integration, information integration and customer sensitivity [26]. Other enablers were identified by Eshlaghy et al., as organizational structure, virtual organization, information technology, organizational culture, leadership, team working, empowerment and improvement, motivation system and planning and evaluation performance [27].

From this literature review, we can notice that there is no single list of agility enablers [20] which is due to the varied requirements of each organization [28]. However, all the enablers should have some criteria and attributes that make them agile. For example, the criterion called “Organizational structure” should be flexible to accept changes, this means that the different attributes of the organizational structure should be easily adaptable [20], while promoting a fluid flow of information [15], communication [29] and knowledge [30], which makes it possible to accept the interchangeability of employees [15] and focus on teamwork [20, 27, 30, 31]. For the other criterion “Processes”, it should be flexible [20, 30], promote and concentrate on external environment developments [20, 30, 32]. According to Sherehiy et al. [30], human resource agility, as an enabler of the agile organization [20], should be flexible [33], multi-skilled [15, 33], adaptable, resilient [20, 30, 32], able to cooperate [15, 20, 30], take personal initiative and cope well with changes [20, 30, 32]. The technology enabler should also be flexible like other enablers, modular and easily scalable [20].

Summarizing the above literature, different enablers, as listed in Table 1, are chosen as necessary conditions for organizational agility [33]. Table 1 suggest an assessment model in which we defined, firstly, the agile enablers that should be implemented by organizations; secondly, for each enabler different agile criteria are listed and finally agile attributes are identified in order to achieve the required agile criteria [15].

Table 1: Organizational agility enablers (Adapted from [12, 15, 27, 29–34])

| Agile enablers | Agile criteria | Agile attributes |
|---|---|--|
| Management responsibility agility (E ₁) | Organizational structure (E ₁₁) | Flattened, horizontal organizational structure that promotes innovation, training and having an open information, communication and knowledge policy (E ₁₁₁) |
| | | Fluid information flow (E ₁₁₂) |
| | | Staff interchangeability (E ₁₁₃) |
| | | Collaborative and team work (E ₁₁₄) |
| | Devolution of authority (E ₁₂) | Clear definition of staff responsibility and authority (E ₁₂₁) |
| | | Training to create self-managed and multi-functional teams (E ₁₂₂) |
| | | Decentralized decision-making, knowledge and control (E ₁₂₃) |
| | | Loyalty and commitment to a project or a group (E ₁₂₄) |
| | | Authority change when tasks change (E ₁₂₅) |
| | Nature of management (E ₁₃) | Participative management style (E ₁₃₁) |
| | | Clearly known management purpose (E ₁₃₂) |
| | | Management participation and support (E ₁₃₃) |
| | | Motivation of profit associated with a humanitarian approach (E ₁₃₄) |
| | | Regular conduct of employer–employees meetings (E ₁₃₅) |
| | | Quick evaluation and implementation of employee suggestions (E ₁₃₆) |
| Manufacturing management agility (E ₂) | Patient response adoption (E ₂₁) | Dominance of the culture of continuous improvement (E ₂₁₁) |
| | | Communication media to collect responses (E ₂₁₂) |
| | | Incorporating patient feedback into services (E ₂₁₃) |
| | | Staff empowerment to resolve patient issues (E ₂₁₄) |
| | | Efficient information system and technology (E ₂₁₅) |
| | Change in business and technical processes | Flexible business system (E ₂₂₁) |
| | | Application of business process reengineering to reinvent and reorganize the organization (E ₂₂₂) |

| | | |
|---|--|---|
| | (E ₂₂) | Positive employee attitude towards change, new ideas and technology (E ₂₂₃) |
| | | Risk management (E ₂₂₄) |
| | Outsourcing (E ₂₃) | Adopting supply chain management concepts to improve the efficiency of outsourcing (E ₂₃₁) |
| | | Exploitation of information technology (IT) in supply chain management (E ₂₃₂) |
| | | Involvement of suppliers and different agents in product/service development (E ₂₃₃) |
| | | Working with fewer qualified suppliers (E ₂₃₄) |
| | Processes sensing (E ₂₄) | Promoting and concentrating on external environment developments (E ₂₄₁) |
| | Processes responding (E ₂₅) | Reconfigurable process (E ₂₅₁) |
| | | Scalable process (E ₂₅₂) |
| | | Simple process to implement (E ₂₅₃) |
| | Concurrent engineering (E ₂₆) | Process design (E ₂₆₁) |
| | | Intelligent Engineering Design Support System (E ₂₆₂) |
| | | Integrated multidisciplinary teams of customers and suppliers (E ₂₆₃) |
| Continuous reengineering of the organization and business processes based on benchmarking (E ₂₆₄) | | |
| Human resource agility (E ₃) | Employee status (E ₃₁) | Flexible employees to accept the adoption of new technologies (E ₃₁₁) |
| | | Multi-skilled and flexible staff (E ₃₁₂) |
| | | Implementation of job rotation system (E ₃₁₃) |
| | | Education and training for all the existing and new employees (E ₃₁₄) |
| | Employee involvement (E ₃₂) | Employee cooperation (E ₃₂₁) |
| | | Employee empowerment (E ₃₂₂) |
| | Human resource management practices (E ₃₃) | Entrepreneurial organizational culture (E ₃₃₁) |
| | | Reward programs to encourage innovation and based on financial and non-financial measures (E ₃₃₂) |
| | | Multi-skill training improving organizational agility (E ₃₃₃) |
| | | Multi-functional, developed and trained employees (E ₃₃₄) |
| | | Development of differentiation and diversity (E ₃₃₅) |
| | Human resources capacities (E ₃₄) | Anticipation of problems linked to change and resolution of these problems (E ₃₄₁) |
| | | Personal initiative (E ₃₄₂) |
| | | Interpersonal and cultural adaptability (E ₃₄₃) |
| | | Resiliency (E ₃₄₄) |
| | Coordination (E ₃₅) | Personal, informal, goal-oriented and spontaneous coordination (E ₃₅₁) |
| | | Network communication (E ₃₅₂) |
| | | Management-employee cohesion (E ₃₅₃) |
| | Human knowledge and skills (E ₃₆) | Knowledge and skills management systems (E ₃₆₁) |
| | | Protection of sensitive information (E ₃₆₂) |
| Knowledge acquisition from internal and external sources (E ₃₆₃) | | |
| Technology agility (E ₄) | Manufacturing set-ups (E ₄₁) | Flexible manufacturing setups (E ₄₁₁) |
| | | Less time to change machine settings (E ₄₁₂) |
| | | Modernization of machines (E ₄₁₃) |
| | | Usage of collapsible set-ups, Jigs and Fixtures (E ₄₁₄) |
| | | Usage of automated tools (E ₄₁₅) |
| | | Active policy to keep work areas clean and tidy (E ₄₁₆) |
| | Product life cycle (E ₄₂) | Specification of product life to the patient (E ₄₂₁) |
| | | Company encourages patient to switch to new product (E ₄₂₂) |
| | | Products superior field performance for a stipulated period with least maintenance cost (E ₄₂₃) |
| | Product service (E ₄₃) | Products designed for easy serviceability (E ₄₃₁) |
| | | Products incorporated with a modular design (E ₄₃₂) |

| | | |
|--|---|--|
| | | Service centers well equipped with spares (E ₄₃₃) |
| | | Minimum time required to execute the planning and to restore the defective product to its original performance (E ₄₃₄) |
| | Production methodology (E ₄₄) | Management's interest towards investment on flexible manufacturing system (FMS) concepts (E ₄₄₁) |
| | | Application of Lean manufacturing principles for waste elimination (E ₄₄₂) |
| | | Development of products whose components are all outsourced and assembled in-house (E ₄₄₃) |
| | | IT application for better supplier management (E ₄₄₄) |
| | Manufacturing planning (E ₄₅) | Execution of short range planning (E ₄₅₁) |
| | | Organization's procurement policy based on time schedule (E ₄₅₂) |
| | | Strategic network in supply chain management to exercise zero inventory system (E ₄₅₃) |
| | | Improved manufacturing technology (E ₄₅₄) |
| | | Structured and flexible manufacturing processes (E ₄₅₅) |
| | IT integration (E ₄₆) | IT utilities incorporated with reengineered pattern of working (E ₄₆₁) |
| | | Electronic commerce [27] (E ₄₆₂) |
| | Customization (E ₄₇) | Rapid introduction of new products/services (E ₄₇₁) |
| | | Responding to changing market requirements (E ₄₇₂) |
| | | Products with high added value (E ₄₇₃) |
| First-time correct design (E ₄₇₄) | | |
| Manufacturing strategy agility (E ₅) | Status of quality (E ₅₁) | Products/services exceeding patient expectations (E ₅₁₁) |
| | | Carrying out surveys/studies to guarantee the quality status (E ₅₁₂) |
| | | Usage of total quality management tools (E ₅₁₃) |
| | Status of productivity (E ₅₂) | Improved productivity in all functions (E ₅₂₁) |
| | | Reduction of non value-adding costs (E ₅₂₂) |
| | | Quality is not infused at the cost of productivity (E ₅₂₃) |
| | Cost management (E ₅₃) | Costing and product pricing system focused on value-added and non-value-added activities (E ₅₃₁) |
| | | Costing system enabling the evaluation of future resource consumption (E ₅₃₂) |
| | | Product cost fixed according to the pricing of the customer (E ₅₃₃) |
| | Time management (E ₅₄) | Scheduled activities (E ₅₄₁) |
| | | IT based communication system (E ₅₄₂) |
| | | Adoption of time compression technologies (E ₅₄₃) |

3. Fuzzy logic methodology to evaluate organizational agility

In order to enhance organizational agility in practice, the use of different methods and tools were recommended in literature [11, 23]. Focusing on methodological articles [11], the fuzzy logic approach has been used to assess the current agility level and identify the weaker attributes that need a particular attention to enhance the organizational agility. This approach is preferred over other methodologies because it can take the linguistic data as input, then convert linguistic expressions into corresponding fuzzy intervals and finally express the results back in linguistic terms with the help of Fuzzy Agility Index (FAI) [5].

Many studies in literature have used fuzzy logic to measure agility level of the healthcare organization (e.g. [5, 35]). Taking cues from these papers, this study uses this approach to evaluate the agility of a Moroccan healthcare organization.

4. Numerical illustration of fuzzy logic approach

4.1. About the healthcare organization

Our study has been done at a public hospital (referred as HealthOrg), located in Morocco and where patients can carry out

the diagnosis of COVID-19. In order to cope with the new dynamic environment, HealthOrg aims to strengthen its agility level. However, it found it difficult to identify enablers that influence its agility, in particular the weaker ones which need to be improved [15]. In this context, we aimed to evaluate the agility of HealthOrg.

Table 2 provides an illustration of different steps to apply the fuzzy logic approach [11].

Table 2: Steps required applying the fuzzy logic methodology (Adapted from [5, 32])

| Steps |
|---|
| Identify a list of agile enablers that influence the organizational agility. |
| Define the linguistic variables for evaluating performance rating and importance weights of agile attributes. |
| Approximate the linguistic terms by the corresponding fuzzy intervals. |
| Calculate the FAI of the organization. |
| Match the FAI with the appropriate linguistic level. |
| Calculate Fuzzy Performance Importance Index (FPPI). |

4.2. Fuzzy logic application

- Step1: Identification of agile enablers, criteria and attributes [32]: By identifying a list of five agile enablers from the literature [5], twenty-six criteria and ninety-eight attributes were identified (Table 1).
- Step 2: Definition of the linguistic variables for evaluating performance rating and importance weights of agile attributes [32]: Following this list, five experts (E1, E2,..., E5) from HealthOrg were asked to provide the weights in terms of linguistic variables ranging from “Very low (VL)” to “Very High (VH)” and ratings in terms of linguistic variables ranging from “Worst (W)” to “Excellent (E)” [5] (Table 3).

Table 3: Importance weight and performance rating of agile attributes

| Agile attributes | Importance weight | | | | | Performance rating | | | | |
|------------------|-------------------|----|----|----|----|--------------------|----|----|----|----|
| | E1 | E2 | E3 | E4 | E5 | E1 | E2 | E3 | E4 | E5 |
| E111 | H | FH | M | H | FH | E | VG | VG | G | F |
| E112 | H | M | FH | FH | H | P | P | F | G | G |
| E113 | FH | H | FH | H | FH | VP | W | G | F | F |
| E114 | H | M | H | FH | FH | E | G | G | F | F |
| E121 | H | M | FH | M | FH | F | F | G | VG | VG |
| E122 | H | FH | M | H | FH | P | F | P | G | F |
| E123 | FH | H | FH | M | FH | W | W | P | F | P |
| E124 | H | H | M | FH | H | W | W | VP | F | F |
| E125 | M | H | H | FH | H | G | VG | E | E | G |
| E131 | VH | H | H | VH | H | G | F | G | G | VG |
| E132 | H | FH | H | FH | FH | E | E | G | F | E |
| E133 | H | FH | H | FH | H | G | G | G | VG | G |
| E134 | FH | M | FH | M | FH | F | G | F | F | G |
| E135 | H | M | M | M | H | G | G | G | VG | F |
| E136 | VH | H | H | VH | VH | VP | F | P | P | G |
| E137 | H | FH | M | FH | H | W | F | G | F | G |
| E211 | H | H | H | FH | H | G | VG | G | F | F |
| E212 | FH | M | FH | FH | M | W | W | F | G | VP |
| E213 | FH | FH | FH | FH | FH | VP | P | P | F | P |
| E214 | VH | H | H | VH | H | F | G | E | VG | E |
| E215 | H | FH | H | FH | FH | VP | P | W | F | F |
| E221 | FL | M | FL | FL | M | VG | F | E | F | G |
| E222 | H | FH | H | M | FH | W | VP | G | E | G |
| E223 | H | M | M | FH | H | VP | F | F | W | E |
| E224 | FH | H | H | H | FH | F | G | E | VG | G |
| E231 | VH | H | VH | H | H | F | F | G | F | VG |
| E232 | H | M | FH | H | FH | VP | P | G | F | W |
| E233 | H | H | H | H | H | F | W | VP | F | G |
| E234 | FH | H | M | FH | FH | E | VG | F | G | G |
| E241 | H | M | FH | FH | FH | VP | F | G | G | F |
| E251 | H | FH | M | H | M | F | VG | VG | G | VG |
| E252 | FH | FH | FH | FH | FH | VP | VG | F | G | F |
| E253 | FH | M | FH | FH | M | W | W | VP | F | VP |
| E261 | H | FH | H | FH | M | G | F | G | VG | E |
| E262 | H | M | FH | H | H | W | W | G | F | G |
| E263 | FH | M | H | FH | FH | VP | P | W | P | F |
| E264 | H | FH | H | FH | M | G | F | P | VP | G |
| E311 | FH | FH | H | FH | H | P | W | F | G | P |
| E312 | H | H | H | H | H | W | W | F | F | P |
| E313 | VH | H | VH | VH | H | F | G | P | P | P |
| E314 | FH | H | FH | M | FH | E | VG | G | E | F |
| E321 | H | H | H | H | H | E | E | VG | F | F |
| E322 | FH | M | H | H | H | P | F | F | G | VG |
| E331 | H | FH | H | H | M | E | VG | G | F | G |
| E332 | H | H | H | H | H | E | F | G | F | F |
| E333 | H | M | M | M | M | W | W | F | G | F |
| E334 | FH | FH | H | H | FH | W | P | VP | G | F |
| E335 | H | FH | FH | H | H | E | E | E | G | E |

| | | | | | | | | | | |
|------|----|----|----|----|----|----|----|----|----|----|
| E341 | H | M | FH | M | H | VP | P | F | G | F |
| E342 | H | FH | FH | FH | M | F | G | P | F | G |
| E343 | H | FH | H | FH | M | F | E | VG | G | F |
| E344 | H | FH | FH | H | H | G | F | F | E | G |
| E351 | H | H | FH | H | M | VP | F | F | F | F |
| E352 | FH | M | M | FH | FH | E | G | G | F | F |
| E353 | H | FH | H | FH | FH | G | E | F | F | VG |
| E361 | M | M | M | FH | FH | W | W | W | F | P |
| E362 | H | M | FH | FH | H | E | E | E | E | VG |
| E363 | H | FH | H | H | H | E | VG | F | P | F |
| E411 | M | H | M | M | FH | VG | G | F | E | E |
| E412 | FH | FH | M | M | H | W | G | P | F | F |
| E413 | H | M | M | M | FH | G | F | G | E | F |
| E414 | FH | H | H | H | H | G | F | F | F | VG |
| E415 | M | H | FH | H | H | E | G | F | P | VP |
| E416 | FH | H | M | H | FH | W | VP | P | VP | F |
| E421 | H | VH | H | H | H | E | F | G | E | VG |
| E422 | FH | FH | FH | M | H | E | E | G | G | G |
| E423 | H | FH | M | M | FH | E | VG | F | G | G |
| E431 | H | H | FH | H | FH | G | G | VG | E | E |
| E432 | FL | FL | L | VL | M | E | VG | G | VG | E |
| E433 | FL | M | FH | H | FH | G | F | E | E | VG |
| E434 | M | FH | FH | H | VH | VP | P | F | VG | VG |
| E441 | FH | VH | M | FH | VH | E | VG | VG | VG | G |
| E442 | H | M | H | FH | H | G | F | VG | E | VP |
| E443 | FL | H | VH | H | FH | G | F | VP | G | F |
| E444 | VH | H | H | FH | VH | G | E | F | VG | F |
| E451 | VH | VH | H | H | FH | W | VP | F | G | F |
| E452 | VH | VH | H | VH | H | W | W | G | F | F |
| E453 | FH | VH | FH | VH | M | VP | P | G | VG | F |
| E454 | VH | VH | H | FH | FH | G | F | F | VP | P |
| E455 | M | H | VH | H | H | E | VG | G | VG | F |
| E461 | FH | FL | FL | FH | FH | G | G | F | F | F |
| E462 | FH | M | FH | FH | H | VG | E | E | F | G |
| E471 | H | H | FH | H | H | F | F | G | VG | VG |
| E472 | FL | FH | FH | L | FH | E | E | E | VG | G |
| E473 | H | H | FH | FH | H | G | E | VG | F | F |
| E474 | VH | M | VH | H | VH | W | VP | F | G | E |
| E511 | FH | FL | FL | M | FH | F | F | G | F | F |
| E512 | FH | FH | FH | FH | H | E | VP | E | F | G |
| E513 | H | H | M | H | H | E | E | E | E | E |
| E521 | H | FH | VH | H | H | VP | G | E | G | G |
| E522 | VH | M | VH | H | VH | VP | P | P | W | G |
| E523 | H | VH | FH | FL | FL | E | VG | G | E | E |
| E531 | M | M | FH | H | FL | G | E | F | G | F |
| E532 | H | FL | H | M | H | F | F | VG | F | G |
| E533 | M | M | M | M | M | F | F | F | G | G |
| E541 | M | H | FL | M | M | VG | E | F | G | G |
| E542 | H | H | FH | FH | H | G | F | F | F | VG |
| E543 | M | H | M | VL | VL | G | F | F | F | VP |

- Step 3: Approximation of the linguistic terms by the corresponding fuzzy intervals [32]: These linguistic variables were approximated by fuzzy intervals [5] chosen from literature [5, 25] and presented in Table 4.

Table 4: Linguistic variables and fuzzy numbers for weighting and rating of agility (Adapted from [25])

| Importance Weight | | Performance Rating | |
|---------------------|-------------------|---------------------|----------------|
| Linguistic variable | Fuzzy number | Linguistic variable | Fuzzy number |
| Very Low (VL) | (0, 0.05, 0.15) | Worst (W) | (0, 0.5, 1.5) |
| Low (L) | (0.1, 0.2, 0.3) | Very Poor (VP) | (1, 2, 3) |
| Fairly Low (FL) | (0.2, 0.35, 0.5) | Poor (P) | (2, 3.5, 5) |
| Medium (M) | (0.3, 0.5, 0.7) | Fair (F) | (3, 5, 7) |
| Fairly High (FH) | (0.5, 0.65, 0.8) | Good (G) | (5, 6.5, 8) |
| High (H) | (0.7, 0.8, 0.9) | Very Good (VG) | (7, 8, 9) |
| Very High (VH) | (0.85, 0.95, 1.0) | Excellent (E) | (8.5, 9.5, 10) |

To calculate the average fuzzy weight and performance rating of each attribute [5], the literature recommended using average operation method [5, 27].

Example: Average fuzzy weight of the attribute $E_{111} = [H+FH+M+H+FH]/5 = (0.7, 0.8, 0.9)/5, (0.5, 0.65, 0.8)/5, (0.3, 0.5, 0.7)/5, (0.7, 0.8, 0.9)/5, (0.5, 0.65, 0.8)/5 = (0.54, 0.68, 0.82)$

Example: Average fuzzy performance rating of the attribute $E_{111} = [E+VG+VG+G+F]/5 = (8.5, 9.5, 10)/5, (7, 8, 9)/5, (7, 8, 9)/5, (5, 6.5, 8)/5, (3, 5, 7)/5 = (6.1, 7.4, 8.6)$

The following step consists of calculating the rating of each criterion [5]. An example of this calculation for the criterion E_{11} is shown below.

Example: Rating of the criterion

$$E_{11} = \frac{\sum_{k=1}^{k=4} (\text{Average fuzzy performance rating} \otimes \text{Average fuzzy weight})}{\sum_{k=1}^{k=4} \text{Average fuzzy weight}}$$

$$= [(6.1, 7.4, 8.6) \otimes (0.54, 0.68, 0.82) \oplus (3.4, 5.0, 6.6) \otimes (0.54, 0.68, 0.82) \oplus (2.4, 3.8, 5.3) \otimes (0.58, 0.71, 0.84) \oplus (4.9, 6.5, 8.0) \otimes (0.54, 0.68, 0.82)] / [(0.54, 0.68, 0.82) \oplus (0.54, 0.68, 0.82) \oplus (0.58, 0.71, 0.84) \oplus (0.54, 0.68, 0.82)] = (4.17, 5.65, 7.11)$$

By using R language, fuzzy calculations are presented in Table 5.

Table 5: Fuzzy index of agile criteria rating

| Agile criteria | Agile attributes | Average fuzzy performance rating | Average fuzzy weight | Criteria rating |
|-----------------|------------------|----------------------------------|----------------------|--------------------|
| E ₁₁ | E ₁₁₁ | (6.1, 7.4, 8.6) | (0.54, 0.68, 0.82) | (4.17, 5.65, 7.11) |
| | E ₁₁₂ | (3.4, 5.0, 6.6) | (0.54, 0.68, 0.82) | |
| | E ₁₁₃ | (2.4, 3.8, 5.3) | (0.58, 0.71, 0.84) | |
| | E ₁₁₄ | (4.9, 6.5, 8.0) | (0.54, 0.68, 0.82) | |
| E ₁₂ | E ₁₂₁ | (5.0, 6.5, 8.0) | (0.46, 0.62, 0.78) | (3.52, 4.88, 6.28) |
| | E ₁₂₂ | (3.0, 4.7, 6.4) | (0.54, 0.68, 0.82) | |
| | E ₁₂₃ | (1.4, 2.6, 4.0) | (0.50, 0.65, 0.80) | |
| | E ₁₂₄ | (1.4, 2.6, 4.0) | (0.58, 0.71, 0.84) | |
| E ₁₃ | E ₁₂₅ | (6.8, 8.0, 9.0) | (0.58, 0.71, 0.84) | (4.49, 5.99, 7.47) |
| | E ₁₃₁ | (5.0, 6.5, 8.0) | (0.76, 0.86, 0.94) | |
| | E ₁₃₂ | (6.7, 8.0, 9.0) | (0.58, 0.71, 0.84) | |
| | E ₁₃₃ | (5.4, 6.8, 8.2) | (0.62, 0.74, 0.86) | |
| | E ₁₃₄ | (3.8, 5.6, 7.4) | (0.42, 0.59, 0.76) | |
| | E ₁₃₅ | (5.0, 6.5, 8.0) | (0.46, 0.62, 0.78) | |
| | E ₁₃₆ | (2.6, 4.1, 5.6) | (0.79, 0.89, 0.96) | |
| E ₂₁ | E ₁₃₇ | (3.2, 4.7, 6.3) | (0.54, 0.68, 0.82) | (3.66, 4.93, 6.23) |
| | E ₂₁₁ | (4.6, 6.2, 7.8) | (0.66, 0.77, 0.88) | |
| | E ₂₁₂ | (1.8, 2.9, 4.2) | (0.42, 0.59, 0.76) | |
| | E ₂₁₃ | (2.0, 3.5, 5.0) | (0.50, 0.65, 0.80) | |
| | E ₂₁₄ | (6.4, 7.7, 8.8) | (0.76, 0.86, 0.94) | |
| | E ₂₁₅ | (1.8, 3.2, 4.7) | (0.58, 0.71, 0.84) | |
| E ₂₂ | E ₂₂₁ | (5.3, 6.8, 8.2) | (0.24, 0.41, 0.58) | (4.45, 5.77, 7.04) |
| | E ₂₂₂ | (3.9, 5.0, 6.1) | (0.54, 0.68, 0.82) | |
| | E ₂₂₃ | (3.1, 4.4, 5.7) | (0.50, 0.65, 0.80) | |
| | E ₂₂₄ | (5.7, 7.1, 8.4) | (0.62, 0.74, 0.86) | |
| E ₂₃ | E ₂₂₄ | (5.7, 7.1, 8.4) | (0.62, 0.74, 0.86) | (3.56, 5.05, 6.55) |
| | E ₂₃₁ | (4.2, 5.9, 7.6) | (0.76, 0.86, 0.94) | |
| | E ₂₃₂ | (2.2, 3.5, 4.9) | (0.54, 0.68, 0.82) | |
| | E ₂₃₃ | (2.4, 3.8, 5.3) | (0.7, 0.8, 0.9) | |
| E ₂₄ | E ₂₃₄ | (5.7, 7.1, 8.4) | (0.50, 0.65, 0.80) | (3.4, 5.0, 6.6) |
| | E ₂₄₁ | (3.4, 5.0, 6.6) | (0.50, 0.65, 0.80) | |
| E ₂₅ | E ₂₅₁ | (5.8, 7.1, 8.4) | (0.50, 0.65, 0.80) | (3.68, 4.89, 6.18) |
| | E ₂₅₂ | (3.8, 5.3, 6.8) | (0.50, 0.65, 0.80) | |
| | E ₂₅₃ | (1.0, 2.0, 3.2) | (0.42, 0.59, 0.76) | |
| E ₂₆ | E ₂₆₁ | (5.7, 7.1, 8.4) | (0.54, 0.68, 0.82) | |

| | | | | |
|-----------------|------------------|------------------|--------------------|--------------------|
| E ₃₁ | E ₂₆₂ | (2.6, 3.8, 5.2) | (0.58, 0.71, 0.84) | (3.29, 4.63, 6.03) |
| | E ₂₆₃ | (1.6, 2.9, 4.3) | (0.50, 0.65, 0.80) | |
| | E ₂₆₄ | (3.2, 4.7, 6.2) | (0.54, 0.68, 0.82) | |
| E ₃₂ | E ₃₁₁ | (2.4, 3.8, 5.3) | (0.58, 0.71, 0.84) | (3.08, 4.57, 6.06) |
| | E ₃₁₂ | (1.6, 2.9, 4.4) | (0.7, 0.8, 0.9) | |
| | E ₃₁₃ | (2.8, 4.4, 6.0) | (0.79, 0.89, 0.96) | |
| | E ₃₁₄ | (6.4, 7.7, 8.8) | (0.50, 0.65, 0.80) | |
| E ₃₃ | E ₃₂₁ | (6.0, 7.4, 8.6) | (0.7, 0.8, 0.9) | (5.09, 6.55, 7.92) |
| | E ₃₂₂ | (4.0, 5.6, 7.2) | (0.58, 0.71, 0.84) | |
| E ₃₄ | E ₃₃₁ | (5.7, 7.1, 8.4) | (0.58, 0.71, 0.84) | (4.69, 5.97, 7.21) |
| | E ₃₃₂ | (4.5, 6.2, 7.8) | (0.7, 0.8, 0.9) | |
| | E ₃₃₃ | (2.2, 3.5, 5.0) | (0.38, 0.56, 0.74) | |
| | E ₃₃₄ | (2.2, 3.5, 4.9) | (0.58, 0.71, 0.84) | |
| | E ₃₃₅ | (7.8, 8.9, 9.6) | (0.62, 0.74, 0.86) | |
| E ₃₅ | E ₃₄₁ | (2.8, 4.4, 6.0) | (0.50, 0.65, 0.80) | (4.21, 5.79, 7.32) |
| | E ₃₄₂ | (3.6, 5.3, 7.0) | (0.50, 0.65, 0.80) | |
| | E ₃₄₃ | (5.3, 6.8, 8.2) | (0.54, 0.68, 0.82) | |
| E ₃₆ | E ₃₄₄ | (4.9, 6.5, 8.0) | (0.62, 0.74, 0.86) | (4.20, 5.86, 7.45) |
| | E ₃₅₁ | (2.6, 4.4, 6.2) | (0.58, 0.71, 0.84) | |
| | E ₃₅₂ | (4.9, 6.5, 8.0) | (0.42, 0.59, 0.76) | |
| E ₄₁ | E ₃₅₃ | (5.3, 6.8, 8.2) | (0.58, 0.71, 0.84) | (5.01, 6.04, 7.03) |
| | E ₃₆₁ | (1.0, 2.0, 3.3) | (0.38, 0.56, 0.74) | |
| | E ₃₆₂ | (8.2, 9.2, 9.8) | (0.54, 0.68, 0.82) | |
| | E ₃₆₃ | (4.7, 6.2, 7.6) | (0.66, 0.77, 0.88) | |
| E ₄₂ | E ₄₁₁ | (6.4, 7.7, 8.8) | (0.42, 0.59, 0.76) | (3.81, 5.30, 6.74) |
| | E ₄₁₂ | (2.6, 4.1, 5.7) | (0.46, 0.62, 0.78) | |
| | E ₄₁₃ | (4.9, 6.5, 8.0) | (0.42, 0.59, 0.76) | |
| | E ₄₁₄ | (4.2, 5.9, 7.6) | (0.66, 0.77, 0.88) | |
| | E ₄₁₅ | (3.9, 5.3, 6.6) | (0.58, 0.71, 0.84) | |
| | E ₄₁₆ | (1.4, 2.6, 3.9) | (0.54, 0.68, 0.82) | |
| E ₄₃ | E ₄₂₁ | (6.4, 7.7, 8.8) | (0.73, 0.83, 0.92) | (6.21, 7.52, 8.67) |
| | E ₄₂₂ | (6.4, 7.7, 8.8) | (0.50, 0.65, 0.80) | |
| | E ₄₂₃ | (5.7, 7.1, 8.4) | (0.46, 0.62, 0.78) | |
| E ₄₄ | E ₄₃₁ | (6.8, 8.0, 9.0) | (0.62, 0.74, 0.86) | (5.84, 7.14, 8.27) |
| | E ₄₃₂ | (7.2, 8.3, 9.2) | (0.16, 0.29, 0.43) | |
| | E ₄₃₃ | (6.4, 7.7, 8.8) | (0.44, 0.59, 0.74) | |
| | E ₄₃₄ | (4.0, 5.3, 6.6) | (0.57, 0.71, 0.84) | |
| E ₄₅ | E ₄₄₁ | (6.9, 8.0, 9.0) | (0.60, 0.74, 0.86) | (5.14, 6.53, 7.82) |
| | E ₄₄₂ | (4.9, 6.2, 7.4) | (0.58, 0.71, 0.84) | |
| | E ₄₄₃ | (3.4, 5.0, 6.6) | (0.59, 0.71, 0.82) | |
| | E ₄₄₄ | (5.3, 6.8, 8.2) | (0.72, 0.83, 0.92) | |
| | E ₄₅₁ | (2.4, 3.8, 5.3) | (0.72, 0.83, 0.92) | |
| E ₄₆ | E ₄₅₂ | (2.2, 3.5, 5.0) | (0.79, 0.89, 0.96) | (3.34, 4.76, 6.23) |
| | E ₄₅₃ | (3.6, 5.0, 6.4) | (0.60, 0.74, 0.86) | |
| | E ₄₅₄ | (2.8, 4.4, 6.0) | (0.68, 0.80, 0.90) | |
| | E ₄₅₅ | (6.1, 7.4, 8.6) | (0.65, 0.77, 0.88) | |
| E ₄₇ | E ₄₆₁ | (3.8, 5.6, 7.4) | (0.38, 0.53, 0.68) | (5.28, 6.76, 8.16) |
| | E ₄₆₂ | (6.4, 7.7, 8.8) | (0.50, 0.65, 0.80) | |
| | E ₄₇₁ | (5.0, 6.5, 8.0) | (0.66, 0.77, 0.88) | |
| | E ₄₇₂ | (7.5, 8.6, 9.4) | (0.36, 0.50, 0.64) | |
| E ₅₁ | E ₄₇₃ | (5.3, 6.8, 8.2) | (0.62, 0.74, 0.86) | (5.01, 6.42, 7.74) |
| | E ₄₇₄ | (3.5, 4.7, 5.9) | (0.71, 0.83, 0.92) | |
| | E ₅₁₁ | (3.4, 5.3, 7.2) | (0.34, 0.50, 0.66) | |
| E ₅₂ | E ₅₁₂ | (5.2, 6.5, 7.6) | (0.54, 0.68, 0.82) | (6.16, 7.34, 8.37) |
| | E ₅₁₃ | (8.5, 9.5, 10.0) | (0.62, 0.74, 0.86) | |
| | E ₅₂₁ | (4.9, 6.2, 7.4) | (0.69, 0.80, 0.90) | |
| | E ₅₂₂ | (2.0, 3.2, 4.5) | (0.71, 0.83, 0.92) | |
| E ₅₃ | E ₅₂₃ | (7.5, 8.6, 9.4) | (0.49, 0.62, 0.74) | (4.48, 5.75, 6.93) |
| | E ₅₃₁ | (4.9, 6.5, 8.0) | (0.40, 0.56, 0.72) | |
| | E ₅₃₂ | (4.2, 5.9, 7.6) | (0.52, 0.65, 0.78) | |
| E ₅₄ | E ₅₃₃ | (3.8, 5.6, 7.4) | (0.3, 0.5, 0.7) | (4.33, 6.01, 7.67) |
| | E ₅₄₁ | (5.7, 7.1, 8.4) | (0.36, 0.53, 0.70) | |
| | E ₅₄₂ | (4.2, 5.9, 7.6) | (0.62, 0.74, 0.86) | |
| | E ₅₄₃ | (3.0, 4.7, 6.4) | (0.26, 0.38, 0.52) | |

In order to calculate the rating of each enabler, we firstly aggregate the five experts' weights and ratings, by using median operation [25], and then we carry out the same calculation as that of the criteria rating (Table 6). An example of the rating of the enabler E_1 is shown below.

Example: Rating of the enabler

$$E_1 = \frac{\sum_{j=1}^{j=3} (\text{Criteria rating} \otimes \text{Fuzzy importance weight of the agile criteria})}{\sum_{j=1}^{j=3} \text{Fuzzy importance weight of the agile criteria}}$$

$$= [(4.17, 5.65, 7.11) \otimes (0.5, 0.65, 0.8) \oplus (3.52, 4.88, 6.28) \otimes (0.5, 0.65, 0.8) \oplus (4.49, 5.99, 7.47) \otimes (0.5, 0.65, 0.8)] / [(0.5, 0.65, 0.8) \oplus (0.5, 0.65, 0.8) \oplus (0.5, 0.65, 0.8)] = (5.14, 6.55, 7.86)$$

Table 6: Fuzzy index of agile enabler rating

| Agile enablers | Agile criteria | Criteria rating | Fuzzy importance weight of the agile criteria | Enabler rating | Fuzzy importance weight of the agile enablers |
|----------------|-----------------|--------------------|---|--------------------|---|
| E ₁ | E ₁₁ | (4.17, 5.65, 7.11) | (0.5, 0.65, 0.8) | (5.14, 6.55, 7.86) | (0.5, 0.65, 0.8) |
| | E ₁₂ | (3.52, 4.88, 6.28) | (0.5, 0.65, 0.8) | | |
| | E ₁₃ | (4.49, 5.99, 7.47) | (0.5, 0.65, 0.8) | | |
| E ₂ | E ₂₁ | (3.66, 4.93, 6.23) | (0.5, 0.65, 0.8) | (3.67, 5.04, 6.44) | (0.5, 0.65, 0.8) |
| | E ₂₂ | (4.45, 5.77, 7.04) | (0.5, 0.65, 0.8) | | |
| | E ₂₃ | (3.56, 5.05, 6.55) | (0.7, 0.8, 0.9) | | |
| | E ₂₄ | (3.4, 5.0, 6.6) | (0.5, 0.65, 0.8) | | |
| | E ₂₅ | (3.68, 4.89, 6.18) | (0.5, 0.65, 0.8) | | |
| | E ₂₆ | (3.29, 4.63, 6.03) | (0.5, 0.65, 0.8) | | |
| E ₃ | E ₃₁ | (3.08, 4.57, 6.06) | (0.7, 0.8, 0.9) | (4.36, 5.79, 7.16) | (0.7, 0.8, 0.9) |
| | E ₃₂ | (5.09, 6.55, 7.92) | (0.7, 0.8, 0.9) | | |
| | E ₃₃ | (4.69, 5.97, 7.21) | (0.7, 0.8, 0.9) | | |
| | E ₃₄ | (4.21, 5.79, 7.32) | (0.5, 0.65, 0.8) | | |
| | E ₃₅ | (4.20, 5.86, 7.45) | (0.5, 0.65, 0.8) | | |
| | E ₃₆ | (5.01, 6.04, 7.03) | (0.5, 0.65, 0.8) | | |
| E ₄ | E ₄₁ | (3.81, 5.30, 6.74) | (0.5, 0.65, 0.8) | (4.88, 6.31, 7.64) | (0.5, 0.65, 0.8) |
| | E ₄₂ | (6.21, 7.52, 8.67) | (0.5, 0.65, 0.8) | | |
| | E ₄₃ | (5.84, 7.14, 8.27) | (0.5, 0.65, 0.8) | | |
| | E ₄₄ | (5.14, 6.53, 7.82) | (0.7, 0.8, 0.9) | | |
| | E ₄₅ | (3.34, 4.76, 6.23) | (0.7, 0.8, 0.9) | | |
| | E ₄₆ | (5.28, 6.76, 8.16) | (0.5, 0.65, 0.8) | | |
| | E ₄₇ | (5.01, 6.42, 7.74) | (0.7, 0.8, 0.9) | | |
| E ₅ | E ₅₁ | (6.16, 7.34, 8.37) | (0.5, 0.65, 0.8) | (4.90, 6.28, 7.61) | (0.5, 0.65, 0.8) |
| | E ₅₂ | (4.48, 5.75, 6.93) | (0.7, 0.8, 0.9) | | |
| | E ₅₃ | (4.33, 6.01, 7.67) | (0.3, 0.5, 0.7) | | |
| | E ₅₄ | (4.38, 6.01, 7.57) | (0.3, 0.5, 0.7) | | |

- Step 4: Calculation of the FAI of HealthOrg: We carry out the same calculation as that of the enabler rating [32].

$$FAI = \frac{\sum_{i=1}^{i=5} (\text{Enabler rating} \otimes \text{Fuzzy importance weight of the agile enablers})}{\sum_{i=1}^{i=5} \text{Fuzzy importance weight of the agile enablers}}$$

$$= [(5.14, 6.55, 7.86) \otimes (0.5, 0.65, 0.8) \oplus (3.67, 5.04, 6.44) \otimes (0.5, 0.65, 0.8) \oplus (4.36, 5.79, 7.16) \otimes (0.7, 0.8, 0.9) \oplus (4.88, 6.31, 7.64) \otimes (0.5, 0.65, 0.8) \oplus (4.90, 6.28, 7.61) \otimes (0.5, 0.65, 0.8)] / [(0.5, 0.65, 0.8) \oplus (0.5, 0.65, 0.8) \oplus (0.7, 0.8, 0.9) \oplus (0.5, 0.65, 0.8) \oplus (0.5, 0.65, 0.8)] = (4.57, 5.98, 7.34)$$

The overall agility of HealthOrg is (4.57, 5.98, 7.34).

- Step 5: Matching the FAI with the appropriate linguistic level [32]: After determining the FAI of the organization, we converted it into linguistic terms. To do this, we used the Euclidean distance method in which we seek to obtain the minimum distance between FAI and the linguistic level (Table 8). Table 7 presents the linguistic terms of different agility levels and their fuzzy intervals [5].

Table 7: Fuzzy values of agility levels (Adapted from [25])

| Level of agility | Fuzzy intervals |
|------------------|-----------------|
| Slowly Agile | (0, 1.5, 3) |
| Fairly Agile | (1.5, 3, 4.5) |
| Agile | (3.5, 5, 6.5) |
| Very Agile | (5.5, 7, 8.5) |
| Extremely Agile | (7, 8.5, 10) |

Table 8: Agility level of HealthOrg

| FAI for HealthOrg | (4.57, 5.98, 7.34) |
|--------------------------|---|
| D (FAI, Slowly Agile) | $\{(4.57-0)^2 + (5.98-1.5)^2 + (7.34-3)^2\}^{1/2} = 7.78$ |
| D (FAI, Fairly Agile) | $\{(4.57-1.5)^2 + (5.98-3)^2 + (7.34-4.5)^2\}^{1/2} = 5.13$ |
| D (FAI, Agile) | $\{(4.57-3.5)^2 + (5.98-5.0)^2 + (7.34-6.5)^2\}^{1/2} = 1.67$ |
| D (FAI, Very Agile) | $\{(4.57-5.5)^2 + (5.98-7)^2 + (7.34-8.5)^2\}^{1/2} = 1.80$ |
| D (FAI, Extremely Agile) | $\{(4.57-7)^2 + (5.98-8.5)^2 + (7.34-10)^2\}^{1/2} = 4.40$ |

The minimum distance between FAI and the level of agility is that obtained with the “Agile” level. Then, HealthOrg is considered as an agile enterprise.

- Step 6: Fuzzy performance importance index (FPII) calculation: Although HealthOrg is agile; some attributes weakened its agility during COVID-19 era. In order to identify them, we calculate FPII and the ranking score for each agile attribute (Table 9) [5]. An example of it for E₁₁₁ is calculated as:

FPII₁₁₁ = [(1, 1, 1) – Average fuzzy weight of E₁₁₁] ⊗ Average fuzzy performance rating of

$$E_{111} = [(1, 1, 1) - (0.54, 0.68, 0.82)] \otimes (6.1, 7.4, 8.6) = (2.81, 2.37, 1.55)$$

$$\text{Ranking score of } E_{111} = (2.81 + 4 \times 2.37 + 1.55) / 6 = 2.31$$

Table 9: FPII and ranking score of agile attributes

| Agile Attributes | Average fuzzy weight | Fuzzy performance average rating | FPII | Ranking score |
|------------------|----------------------|----------------------------------|--------------------|---------------|
| E ₁₁₁ | (0.54, 0.68, 0.82) | (6.1, 7.4, 8.6) | (2.81, 2.37, 1.55) | 2.31 |
| E ₁₁₂ | (0.54, 0.68, 0.82) | (3.4, 5.0, 6.6) | (1.56, 1.60, 1.19) | 1.52 |
| E ₁₁₃ | (0.58, 0.71, 0.84) | (2.4, 3.8, 5.3) | (1.01, 1.10, 0.85) | 1.04 |
| E ₁₁₄ | (0.54, 0.68, 0.82) | (4.9, 6.5, 8.0) | (2.25, 2.08, 1.44) | 2.00 |
| E ₁₂₁ | (0.46, 0.62, 0.78) | (5.0, 6.5, 8.0) | (2.70, 2.47, 1.76) | 2.39 |
| E ₁₂₂ | (0.54, 0.68, 0.82) | (3.0, 4.7, 6.4) | (1.38, 1.50, 1.15) | 1.42 |
| E ₁₂₃ | (0.50, 0.65, 0.80) | (1.4, 2.6, 4.0) | (0.70, 0.91, 0.80) | 0.86 |
| E ₁₂₄ | (0.58, 0.71, 0.84) | (1.4, 2.6, 4.0) | (0.59, 0.75, 0.64) | 0.70 |
| E ₁₂₅ | (0.58, 0.71, 0.84) | (6.8, 8.0, 9.0) | (2.86, 2.32, 1.44) | 2.26 |
| E ₁₃₁ | (0.76, 0.86, 0.94) | (5.0, 6.5, 8.0) | (1.20, 0.91, 0.48) | 0.89 |
| E ₁₃₂ | (0.58, 0.71, 0.84) | (6.7, 8.0, 9.0) | (2.81, 2.32, 1.44) | 2.25 |
| E ₁₃₃ | (0.62, 0.74, 0.86) | (5.4, 6.8, 8.2) | (2.05, 1.77, 1.15) | 1.71 |
| E ₁₃₄ | (0.42, 0.59, 0.76) | (3.8, 5.6, 7.4) | (2.20, 2.30, 1.78) | 2.20 |
| E ₁₃₅ | (0.46, 0.62, 0.78) | (5.0, 6.5, 8.0) | (2.70, 2.47, 1.76) | 2.39 |
| E ₁₃₆ | (0.79, 0.89, 0.96) | (2.6, 4.1, 5.6) | (0.55, 0.45, 0.22) | 0.43 |
| E ₁₃₇ | (0.54, 0.68, 0.82) | (3.2, 4.7, 6.3) | (1.47, 1.50, 1.13) | 1.43 |
| E ₂₁₁ | (0.66, 0.77, 0.88) | (4.6, 6.2, 7.8) | (1.56, 1.43, 0.94) | 1.37 |
| E ₂₁₂ | (0.42, 0.59, 0.76) | (1.8, 2.9, 4.2) | (1.04, 1.19, 1.01) | 1.13 |
| E ₂₁₃ | (0.50, 0.65, 0.80) | (2.0, 3.5, 5.0) | (1.00, 1.22, 1.00) | 1.15 |
| E ₂₁₄ | (0.76, 0.86, 0.94) | (6.4, 7.7, 8.8) | (1.54, 1.08, 0.53) | 1.06 |
| E ₂₁₅ | (0.58, 0.71, 0.84) | (1.8, 3.2, 4.7) | (0.76, 0.93, 0.75) | 0.87 |
| E ₂₂₁ | (0.24, 0.41, 0.58) | (5.3, 6.8, 8.2) | (4.03, 4.01, 3.44) | 3.92 |
| E ₂₂₂ | (0.54, 0.68, 0.82) | (3.9, 5.0, 6.1) | (1.79, 1.60, 1.10) | 1.55 |

| | | | | |
|------|--------------------|------------------|--------------------|-------------|
| E223 | (0.50, 0.65, 0.80) | (3.1, 4.4, 5.7) | (1.55, 1.54, 1.14) | 1.47 |
| E224 | (0.62, 0.74, 0.86) | (5.7, 7.1, 8.4) | (2.17, 1.85, 1.18) | 1.79 |
| E231 | (0.76, 0.86, 0.94) | (4.2, 5.9, 7.6) | (1.01, 0.83, 0.46) | 0.80 |
| E232 | (0.54, 0.68, 0.82) | (2.2, 3.5, 4.9) | (1.01, 1.12, 0.88) | 1.06 |
| E233 | (0.7, 0.8, 0.9) | (2.4, 3.8, 5.3) | (0.72, 0.76, 0.53) | 0.71 |
| E234 | (0.50, 0.65, 0.80) | (5.7, 7.1, 8.4) | (2.85, 2.48, 1.68) | 2.41 |
| E241 | (0.50, 0.65, 0.80) | (3.4, 5.0, 6.6) | (1.70, 1.75, 1.32) | 1.67 |
| E251 | (0.50, 0.65, 0.80) | (5.8, 7.1, 8.4) | (2.90, 2.48, 1.68) | 2.42 |
| E252 | (0.50, 0.65, 0.80) | (3.8, 5.3, 6.8) | (1.90, 1.85, 1.36) | 1.78 |
| E253 | (0.42, 0.59, 0.76) | (1.0, 2.0, 3.2) | (0.58, 0.82, 0.77) | 0.77 |
| E261 | (0.54, 0.68, 0.82) | (5.7, 7.1, 8.4) | (2.62, 2.27, 1.51) | 2.20 |
| E262 | (0.58, 0.71, 0.84) | (2.6, 3.8, 5.2) | (1.09, 1.10, 0.83) | 1.05 |
| E263 | (0.50, 0.65, 0.80) | (1.6, 2.9, 4.3) | (0.80, 1.01, 0.86) | 0.95 |
| E264 | (0.54, 0.68, 0.82) | (3.2, 4.7, 6.2) | (1.47, 1.50, 1.12) | 1.43 |
| E311 | (0.58, 0.71, 0.84) | (2.4, 3.8, 5.3) | (1.01, 1.10, 0.85) | 1.04 |
| E312 | (0.7, 0.8, 0.9) | (1.6, 2.9, 4.4) | (0.48, 0.58, 0.44) | 0.54 |
| E313 | (0.79, 0.89, 0.96) | (2.8, 4.4, 6.0) | (0.59, 0.48, 0.24) | 0.46 |
| E314 | (0.50, 0.65, 0.80) | (6.4, 7.7, 8.8) | (3.20, 2.69, 1.76) | 2.62 |
| E321 | (0.7, 0.8, 0.9) | (6.0, 7.4, 8.6) | (1.80, 1.48, 0.86) | 1.43 |
| E322 | (0.58, 0.71, 0.84) | (4.0, 5.6, 7.2) | (1.68, 1.62, 1.15) | 1.55 |
| E331 | (0.58, 0.71, 0.84) | (5.7, 7.1, 8.4) | (2.39, 2.06, 1.34) | 1.99 |
| E332 | (0.7, 0.8, 0.9) | (4.5, 6.2, 7.8) | (1.35, 1.24, 0.78) | 1.18 |
| E333 | (0.38, 0.56, 0.74) | (2.2, 3.5, 5.0) | (1.36, 1.54, 1.30) | 1.47 |
| E334 | (0.58, 0.71, 0.84) | (2.2, 3.5, 4.9) | (0.92, 1.01, 0.78) | 0.96 |
| E335 | (0.62, 0.74, 0.86) | (7.8, 8.9, 9.6) | (2.96, 2.31, 1.34) | 2.26 |
| E341 | (0.50, 0.65, 0.80) | (2.8, 4.4, 6.0) | (1.40, 1.54, 1.20) | 1.46 |
| E342 | (0.50, 0.65, 0.80) | (3.6, 5.3, 7.0) | (1.80, 1.85, 1.40) | 1.77 |
| E343 | (0.54, 0.68, 0.82) | (5.3, 6.8, 8.2) | (2.44, 2.18, 1.48) | 2.11 |
| E344 | (0.62, 0.74, 0.86) | (4.9, 6.5, 8.0) | (1.86, 1.69, 1.12) | 1.62 |
| E351 | (0.58, 0.71, 0.84) | (2.6, 4.4, 6.2) | (1.09, 1.28, 0.99) | 1.20 |
| E352 | (0.42, 0.59, 0.76) | (4.9, 6.5, 8.0) | (2.84, 2.66, 1.92) | 2.57 |
| E353 | (0.58, 0.71, 0.84) | (5.3, 6.8, 8.2) | (2.23, 1.97, 1.31) | 1.90 |
| E361 | (0.38, 0.56, 0.74) | (1.0, 2.0, 3.3) | (0.62, 0.88, 0.86) | 0.83 |
| E362 | (0.54, 0.68, 0.82) | (8.2, 9.2, 9.8) | (3.77, 2.94, 1.76) | 2.88 |
| E363 | (0.66, 0.77, 0.88) | (4.7, 6.2, 7.6) | (1.60, 1.43, 0.91) | 1.37 |
| E411 | (0.42, 0.59, 0.76) | (6.4, 7.7, 8.8) | (3.71, 3.16, 2.11) | 3.08 |
| E412 | (0.46, 0.62, 0.78) | (2.6, 4.1, 5.7) | (1.40, 1.56, 1.25) | 1.48 |
| E413 | (0.42, 0.59, 0.76) | (4.9, 6.5, 8.0) | (2.84, 2.66, 1.92) | 2.57 |
| E414 | (0.66, 0.77, 0.88) | (4.2, 5.9, 7.6) | (1.43, 1.36, 0.91) | 1.30 |
| E415 | (0.58, 0.71, 0.84) | (3.9, 5.3, 6.6) | (1.64, 1.54, 1.06) | 1.48 |
| E416 | (0.54, 0.68, 0.82) | (1.4, 2.6, 3.9) | (0.64, 0.83, 0.70) | 0.78 |
| E421 | (0.73, 0.83, 0.92) | (6.4, 7.7, 8.8) | (1.73, 1.31, 0.70) | 1.28 |
| E422 | (0.50, 0.65, 0.80) | (6.4, 7.7, 8.8) | (3.20, 2.69, 1.76) | 2.62 |
| E423 | (0.46, 0.62, 0.78) | (5.7, 7.1, 8.4) | (3.08, 2.70, 1.85) | 2.62 |
| E431 | (0.62, 0.74, 0.86) | (6.8, 8.0, 9.0) | (2.58, 2.08, 1.26) | 2.03 |
| E432 | (0.16, 0.29, 0.43) | (7.2, 8.3, 9.2) | (6.05, 5.89, 5.24) | 5.81 |
| E433 | (0.44, 0.59, 0.74) | (6.4, 7.7, 8.8) | (3.58, 3.16, 2.29) | 3.08 |
| E434 | (0.57, 0.71, 0.84) | (4.0, 5.3, 6.6) | (1.72, 1.54, 1.06) | 1.49 |
| E441 | (0.60, 0.74, 0.86) | (6.9, 8.0, 9.0) | (2.76, 2.08, 1.26) | 2.06 |
| E442 | (0.58, 0.71, 0.84) | (4.9, 6.2, 7.4) | (2.06, 1.80, 1.18) | 1.74 |
| E443 | (0.59, 0.71, 0.82) | (3.4, 5.0, 6.6) | (1.39, 1.45, 1.19) | 1.40 |
| E444 | (0.72, 0.83, 0.92) | (5.3, 6.8, 8.2) | (1.48, 1.16, 0.66) | 1.13 |
| E451 | (0.72, 0.83, 0.92) | (2.4, 3.8, 5.3) | (0.67, 0.65, 0.42) | 0.61 |
| E452 | (0.79, 0.89, 0.96) | (2.2, 3.5, 5.0) | (0.46, 0.38, 0.20) | 0.36 |
| E453 | (0.60, 0.74, 0.86) | (3.6, 5.0, 6.4) | (1.44, 1.30, 0.90) | 1.26 |
| E454 | (0.68, 0.80, 0.90) | (2.8, 4.4, 6.0) | (0.90, 0.88, 0.60) | 0.84 |
| E455 | (0.65, 0.77, 0.88) | (6.1, 7.4, 8.6) | (2.13, 1.70, 1.03) | 1.66 |
| E461 | (0.38, 0.53, 0.68) | (3.8, 5.6, 7.4) | (2.36, 2.63, 2.37) | 2.54 |
| E462 | (0.50, 0.65, 0.80) | (6.4, 7.7, 8.8) | (3.20, 2.69, 1.76) | 2.62 |
| E471 | (0.66, 0.77, 0.88) | (5.0, 6.5, 8.0) | (1.70, 1.49, 0.96) | 1.44 |
| E472 | (0.36, 0.50, 0.64) | (7.5, 8.6, 9.4) | (4.80, 4.30, 3.38) | 4.23 |
| E473 | (0.62, 0.74, 0.86) | (5.3, 6.8, 8.2) | (2.01, 1.77, 1.15) | 1.71 |
| E474 | (0.71, 0.83, 0.92) | (3.5, 4.7, 5.9) | (1.01, 0.80, 0.47) | 0.78 |
| E511 | (0.34, 0.50, 0.66) | (3.4, 5.3, 7.2) | (2.24, 2.65, 2.45) | 2.55 |
| E512 | (0.54, 0.68, 0.82) | (5.2, 6.5, 7.6) | (2.39, 2.08, 1.37) | 2.01 |
| E513 | (0.62, 0.74, 0.86) | (8.5, 9.5, 10.0) | (3.23, 2.47, 1.40) | 2.42 |
| E521 | (0.69, 0.80, 0.90) | (4.9, 6.2, 7.4) | (1.52, 1.24, 0.74) | 1.20 |
| E522 | (0.71, 0.83, 0.92) | (2.0, 3.2, 4.5) | (0.58, 0.54, 0.36) | 0.52 |
| E523 | (0.49, 0.62, 0.74) | (7.5, 8.6, 9.4) | (3.82, 3.27, 2.44) | 3.22 |
| E531 | (0.40, 0.56, 0.72) | (4.9, 6.5, 8.0) | (2.94, 2.86, 2.24) | 2.77 |
| E532 | (0.52, 0.65, 0.78) | (4.2, 5.9, 7.6) | (2.02, 2.06, 1.67) | 1.99 |

| | | | | |
|------|--------------------|-----------------|--------------------|------|
| E533 | (0.3, 0.5, 0.7) | (3.8, 5.6, 7.4) | (2.66, 2.80, 2.22) | 2.68 |
| E541 | (0.36, 0.53, 0.70) | (5.7, 7.1, 8.4) | (3.65, 3.34, 2.52) | 3.25 |
| E542 | (0.62, 0.74, 0.86) | (4.2, 5.9, 7.6) | (1.60, 1.53, 1.06) | 1.46 |
| E543 | (0.26, 0.38, 0.52) | (3.0, 4.7, 6.4) | (2.22, 2.91, 3.07) | 2.82 |

Based on the five experts' experience, scale 1.1 was considered as the threshold which distinguishes the weaker attributes than the other ones. Table 10 showed these attributes and some suggestions to improve them [5].

Table 10: Weaker agile attributes and improvement proposals

| Weak agile attribute | References | Improvement proposals |
|---|--------------------------|---|
| <ul style="list-style-type: none"> Staff interchangeability Multi-skilled and flexible staff Implementation of job rotation system | [15, 33] | Prepare employees to participate in the implementation of job rotation system |
| <ul style="list-style-type: none"> Flexible employees to accept the adoption of new technologies Multi-functional, developed and trained employees | [15, 29] | Develop a flexible working environment for employees |
| <ul style="list-style-type: none"> Decentralized decision-making, knowledge and control Knowledge and skills management systems Staff empowerment to resolve patient issues | [15, 29, 30, 31, 33] | Give authority to different level employees which contributes to improved their knowledge |
| <ul style="list-style-type: none"> Loyalty and commitment to a project or a group Participative management style Quick evaluation and implementation of employee suggestions Involvement of suppliers and different agents in product/service development | [15, 29, 30] | Remove barriers to facilitate the participation of different employees and suppliers |
| <ul style="list-style-type: none"> Efficient information system and technology Exploitation of information technology (IT) in supply chain management | [15, 27, 29, 30, 32, 33] | Link information systems to technology |
| <ul style="list-style-type: none"> Adopting supply chain management concepts to improve the efficiency of outsourcing Simple process to implement Intelligent Engineering Design Support System Active policy to keep work areas clean and tidy Execution of short range planning Company's procurement policy based on time schedule Improved manufacturing technology First-time correct design Reduction of non value-adding costs | | Use advanced technologies and production methods |

5. Conclusion

This study evaluated organization agility of a public hospital in Morocco in times of COVID-19. The enablers influencing agility were studied, as were the agile criteria and attributes. After a literature review, an assessment model was presented and tested via the fuzzy logic approach. Empirical results showed that HealthOrg is agile. The COVID-19 outbreak has revealed how different enablers can influence the hospital agility. It has also shown how some agile enablers need to be enhanced in order to increase the healthcare organization agility.

This article offers initial empirical exploration on how Moroccan healthcare organizations cope with the COVID-19 crisis. It allows identifying the required changes to improve the agility of the organization. There will be increasing improvement for hospitals in technology and human resources departments; COVID-19 has demonstrated their importance in making the healthcare organization extremely agile.

Despite the above benefits for using the assessment model, there is some limitation: this model does not take into account the different agile drivers and capacities which must be aligned with the agile enablers. Also, the organizational agility assessment has been done for a single healthcare organization; however future research should replicate the assessment model in other organizations, in public and private sector. Also, it is highly recommended to compare the results obtained in times of COVID-19 with those provided by previous studies. Moreover, further practical suggestions for healthcare sector through COVID 19 outbreaks should be provided.

Conflict of Interest

The authors declare no conflict of interest.

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