Journal of Management and Sustainability; Vol. 12, No. 2; 2022
ISSN 1925-4725 E-ISSN 1925-4733
Published by Canadian Center of Science and Education

The Innovation Management Modelling in the Water Sector in the United Arab Emirates: A Mixed-Methods Study

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Received: February 1, 2022 Accepted: June 2, 2022 Online Published: June 21, 2022

doi:10.5539/jms.v12n2p1 URL: https://doi.org/10.5539/jms.v12n2p1

Abstract

The United Arab Emirates (UAE) is encountering a scarcity of water resources. It is counting on innovation management to alleviate the situation. In that context, there is a need for a managerial framework for this subject. Therefore, the aim of the current study is to build up an innovative managerial model. To establish this model, we applied a convergent, parallel, mixed-methods design. The study participants (n = 42) consisted mostly of leaders and experts working for the main water institutions. We analysed the quantitative method via partial least squares structural equation modelling (PLS-SEM), a SmartPLS software. Qualitative method procedures were conducted starting from coding, categorising, obtaining themes, and lastly, the establishment of grounded theory. We obtained two rigid inputs (quantitative and qualitative models) for the last phase (mixed-methods analysis). The quantitative findings revealed a significant and robust relationship (t value = 26.6, p = 0.000, coefficient = 0.888, R^2 = 0.788). The qualitative findings also produced a steady grounded theory. Both quantitative and qualitative models were crossed according to the 'convergence coding matrix' and 'triangulation analysis protocol'. Ultimately, we built a holistic framework named 'the UAE water innovation model', consisting of 12 components (meta-themes). This model should be adopted as the main guide for innovation management and strategy in water public sector institutions. Globally, this model could be a significant contribution, and it would be applicable to any country in the world with the same arid environment as the UAE.

Keywords: balanced scorecard, innovation management, modelling, technology transfer, water sector, public sector

1. Introduction

This study's original contribution is devising a new managerial framework for solving water challenges in United Arab Emirates (UAE) (Figure 1). The main motivation for conducting this study was to reconcile with the water innovation strategy accredited by the UAE government. It also contributes to many national initiatives, such as the UAE Water Security Strategy 2036 and the National Water and Energy Demand Management Program (https://www.moei.gov.ae).

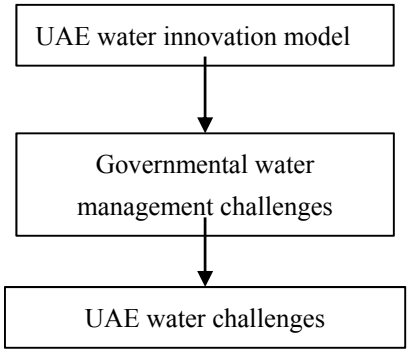

Figure 1. The relationship between the water innovation model and the water challenges in the UAE

The UAE lies within an arid region (FAO, 2008). The water protection and management strategy for sustainable growth in the UAE encompasses three main global challenges: climate change, energy, and the green economy. The implementation of the UAE strategy has been achieved through the integration of several factors, including policy and legislation, institutional framework, innovative technology, education and awareness programs, and partnerships (Alawar, 2015).

The current study selected the domain of management for its fundamental role in the water sector (UNEP, 2011). UNEP stated that the management and conservation of water have become an issue of major worldwide focus because of its dramatic impact on the environment, the economy, and social health.

This study chose the water sector domain because water resources are considered one of the UAE's main priorities. Alawar (2015) stated that the future of the food, energy, and industrial production industry relies significantly on the access to safe and clean water resources, which further stresses the global importance of providing appropriate sanitation services, which has been recognised by the UN because it has set it as one of the Millennium Development Goals. Alawar also indicated that the sustainable and balanced growth of the UAE requires the management and conservation of water resources.

The UAE's water sector consists of several types of institutions. It mainly consists of three types of institutions: the federal ministries, the local governmental authorities, and the semigovernmental institutions. Those institutions include the Ministry of Energy and Infrastructure; the Ministry of Climate Change and Environment, all municipalities; Etihad Water and Electricity (previously the Federal Authority of Water and Electricity [FEWA]); the local water and electricity authorities (such as DEWA, ADWEA, and SEWA); and sewerage interties. In addition, many other bodies support the water sector, such as the Prime Minister's Office (PMO) and the Ministry of Industry and Advanced Technology (standardisation of the water sector).

Innovation management is one of the management pillars in the UAE. The UAE government has established unique innovation enablers that fit with the public sector and the UAE management circumstances. The innovation improvement in the UAE has three dimensions, including the establishment of an innovation centre (www.mbrcgi.gov.ae), stating an innovation criterion and the accreditation of seven national innovation strategies. The water innovation strategy is one of these strategies. In addition, the innovation criterion consists of 20% of the total mark of the model and is considered the second pillar of the award (Figure 3).

The EFQM is committed to helping organisations drive performance improvement through the EFQM excellence model, a comprehensive management framework used by over 30,000 organisations in Europe (http://www.efqm.org). This model is considered one of the present study's theoretical foundations.

Innovation management is a recent topic in the public sector (Bloch & Bugge, 2013; Borins, 2001; Fuglsang & Hansen, 2022; McGann et al., 2018; Sørensen & Torfing, 2012). The public sector in developed countries has a remarkably high income, consisting of around 25% of the GDP (Arundel et al., 2019). The low ability of the public sector to innovate is associated with a negative economic achievement (UN, 2017; United Nations Economic Commission for Europe, 2017). This study contributes to the literature on this sector, discussing recent improvements and challenges in the innovation of that sector.

The current study examines the innovation process via a modelling approach. This simplifies the actuality of the innovation process by (a) the conceptualisation of the problem and (b) conceptualising a model (Roberts et al., 2012). Roberts et al. (2012) stated that modelling plays a significant role in decision-making and addresses uncertainty.

Mixed-methods research plays a significant role in the research community and among practitioners (Greene et al., 1989; Ivankova et al., 2006; Johnson et al., 2007). Mainly it enhances the validity and reliability of the research (Abowitz & Toole, 2010). Using multiple tools for data evaluation is mandated (Cook, 1985). Johnson et al. (2007) and Creswell (2014) defined mixed-methods research as an overlap between quantitative and qualitative research, with a different dominant of the two methods (Johnson et al., 2007). It is an effort to collect and analyse data and then integrate findings (accurate assembling) from both methods in single research project (Bednarz, 1985; Harden & Thomas, 2005; Tashakkori & Creswell, 2007). A mixed-methods study is considered neutral because it resolves the long-running dispute between the quantitative and the qualitative schools (Johnson et al., 2007). The current study adopts this research approach because of its inclusivity and accuracy. Combining quantitative and qualitative findings should be considered whenever possible (Abowitz & Toole, 2010). However, combining between these methods is a challenging case (Almalki, 2016), and it is more expensive than other single methods (Abowitz & Toole, 2010).

2. Literature Review

Many practical and theoretical gaps exist in the water sector in the UAE, specifically in terms of innovation management. The scarcity of water in the UAE and research limitations (mainly innovation modelling) are major gaps. The appropriate development of a model begins with understanding the problem being represented (Roberts et al., 2012).

2.1 Practical Gap

Practically, the UAE is encountering a scarcity of water resources (Alshaali, 2012). Alawar (2015) mentioned the UAE belongs to the arid and semiarid regions. Water challenges such as arid climate, rainfall, evaporation, heavy pumping of groundwater, increasing population, economical reduction, and the water storage affect the sustainable development in the UAE (Murad et al., 2007). Murad et al. emphasised that searching for innovative (nonconventional) water resources is essential.

2.2 Theoretical Gap

Three fundamental theoretical problems are discussed in this study. All of them are categorised to fit the three research methods (quantitative, qualitative, and mixed-method). Quantitative limitations consist of the absence of a 'quantitative model', which is particularly associated with the UAE innovation management. Still, there is a need to structure it in a quantitative and robust statistical model. Therefore, the researchers exert an effort to conceptualise and examine the model obtained from the innovation criteria. These criteria are stated as important by the UAE governmental innovation centre (the highest innovation body in the country) (www.mbrcgi.gov.ae). In the measurable aspect, testing managerial models is a firm approach to empirically justify the model fit and correlations between the different components of the institutional processes (Suárez et al., 2014). Qualitative limitations include the absence of a 'qualitative model', which consists of several themes obtained from the UAE innovation circumstances. Because there is no quantitative and qualitative research (inputs), a 'mixed-methods research model' (the holistic nested form) is missing as well.

The main theoretical problem is the lack of a managerial framework (theory model) for the public innovation process in the water sector in the UAE. What does exist is a group of managerial innovation criteria consisting of a vertical component instead of an interconnected model (www.mbrcgi.gov.ae). However, this is common in the public sector. Particularly in the most critical sectors, such as health management, where the 'whole-system form' is missing (Heirich, 2019). Thus, modelling is a concern in public sector management (O'Toole & Meier, 1999). This reflects the importance of studying innovation management in the public sector in terms of holistic and dynamic conceptualisation (modelling).

According to researchers' knowledge and the research database, there is a lack of research based on the evaluation of the water sector in the UAE. Particularly, there is a lack of studies investigating innovation process modelling, principally in the water sector. Whereas models in many specialisations are common (i.e., the health domain; Roberts et al., 2012), the aim of the current study is to fill this gap in the water sector domain.

3. Research Question Aim and Objectives

The research questions are as follows: (1) How does the innovation process work, and (2) how could it be predicted in the water sector? Mixed-methods outputs should be reflected in a theory, which enhances the applications of the results (Greene et al., 1989). Hence, the general question is, what is the description of the managerial framework model for the innovation process in the water sector in the UAE?

The ultimate aim of this research is related to mixed-methods results. Additionally, the research's input objectives are related to both quantitative and qualitative methods. In the current study, we intend to obtain three models: two input models and one ultimate model. As a result, we sought to achieve three objectives:

1) Build a managerial framework model for the innovation process in the water sector in the UAE via a mixed-methods analysis

2) Conceptualise and examine a rigid quantitative model

3) Develop a steady qualitative grounded theory.

4. Theoretical Foundation

The theoretical foundation is related to the quantitative method aspect. Referring to the targeted model, which consists of two main terms—'innovation' and 'management'we utilized two models. The theoretical foundation for innovation is the government criterion of innovation in the UAE. For management, the EFQM model is the theoretical foundation. However, the innovation criterion is the dominant foundation of the conceptual model in

the present study. Another supportive model related to the qualitative aspect is the balanced scorecard model (BSC), which is applied as a foundation base to direct the grounded theory for the qualitative method.

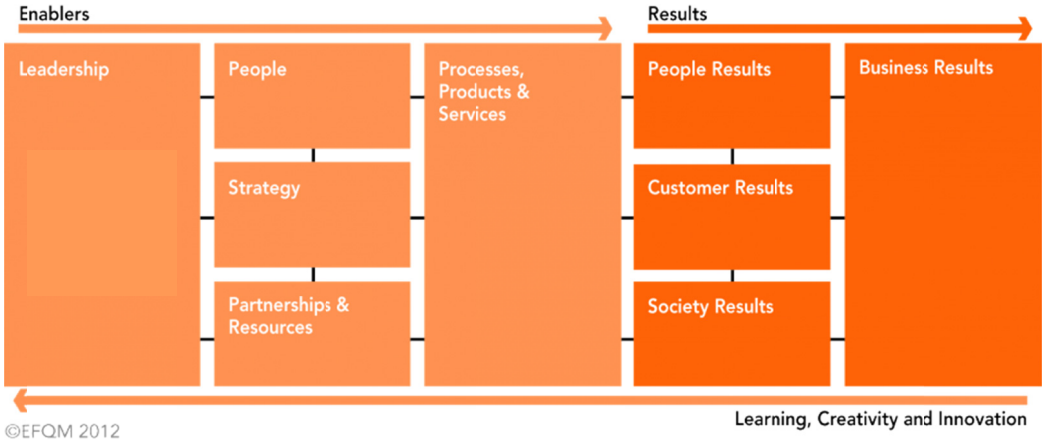

Figure 2. EFQM Model

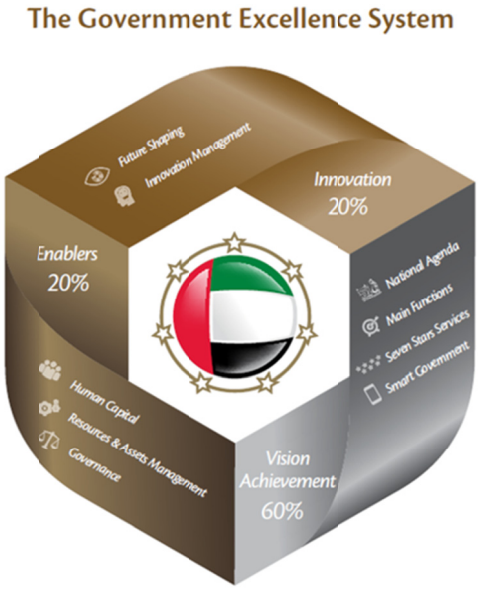

Figure 3. The UAE excellence model showing innovation as a major criterion for the government

The innovation criteria include two groups of items, considered in the current study as a variable directive base (shown below as A and B in Table 1). These criteria are the raw materials that make up the study's quantitative (conceptual) model. Such models are considered a base to establish the study's questionnaire. The questionnaire items are present as a vertical separated component. We aimed at upgrading these items to a consistent correlational model.

Table 1. The study items (approximate variables) in terms of the UAE excellence criteria

A) Enablers (independent variables [IVs]):
Innovation strategy
Management systems
Work environment
Partnership
Human resources capacity
Knowledge and information
B) Results (dependent variables [DVs]):
The ratio of suggestions/ideas submitted per each employee
The number of innovative ideas submitted by customers and partners
The percentage of effective and implemented suggestions/ideas
The number and size of innovative projects implemented with partners
The financial and nonfinancial results achieved as a result of the implantation of innovative ideas in processes and services provision, as well as those that support the achievement of strategic objectives
The amount of additional revenue generated from the implementation of innovative ideas and development of new services
The number of new/improved products and services resulting from innovative ideas
The number of leading work models that have been developed and implemented
The number of published research studies
The number of registered patents/intellectual property rights
The percentage of budget allocated for innovation

All variables were simplified in Figure 4 to be represented in the study's conceptual model.

5. Proposed Quantitative Model

The proposed quantitative model is a simple and basic prediction agent that enables researchers to evaluate the model empirically (O'Toole & Meier, 1999).

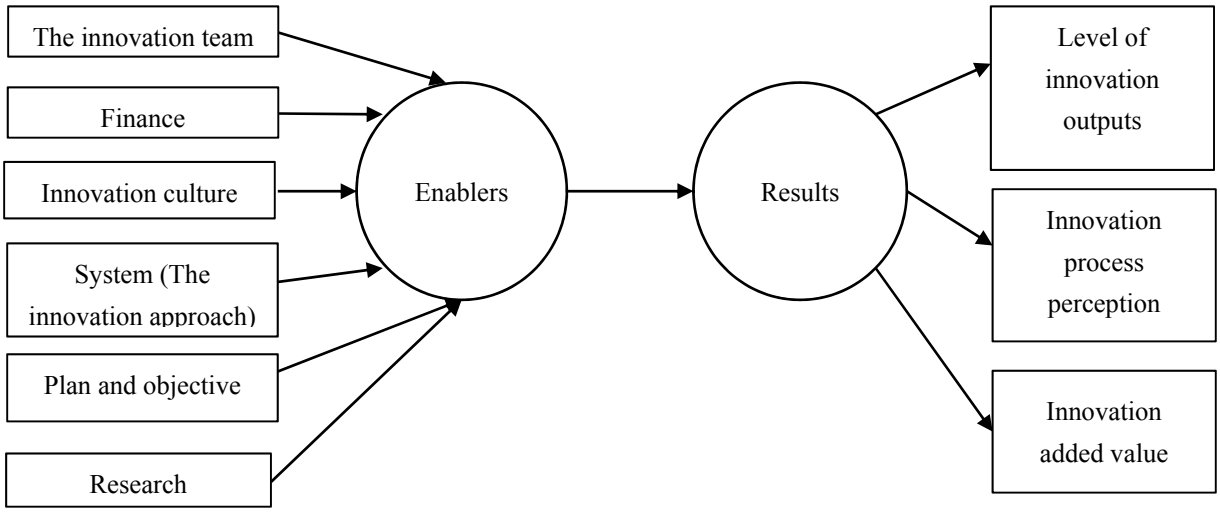

Figure 4. The study's quantitative conceptual model (the theoretical framework)

The simplification relied on transferring the items (approximate variables) to more concentrated (rigid) variables. For instance, the model was designed with generic variables named 'enablers' and 'results'. The 'innovation strategy' was converted to 'plan and objective'. The purpose of this is to ensure participant comprehension of the questionnaire. In the context of the proposed model, a list of examination items was designed (Table 2). The major purpose of this process was to examine the general relation between enablers and results (main hypothesis). In that context, the hypothesis of the study is 'The innovation enablers influence the innovation results'.

6. Methodology

The mixed-methods design is the centric methodology in the current study, which represents the integration of

quantitative and qualitative findings. Both methods were applied at the same time (of equal importance), as a convergent parallel mixed method (Creswell & Clark, 2017; Johnson, et al., 2007). This method was nominated because of the need to compare different perspectives drawn from quantitative and qualitative data (Creswell, 2014). Qualitative and mixed research were adopted in this research because quantitative research alone could not provide an optimum area for policy directions (Roberts et al., 2012). Figure 6 shows the methodology flow.

6.1 Sample

The participants (n = 42) represent the main stakeholders in the water sector, which have strong diversification. Participants' diversity includes managerial and technical employees (Figure 5). The participants were first introduced to the objectives and agenda. We discussed the data collection objectives to ensure all participants were aware of the section's direction and applied qualitative data collection to avoid confusion about the natural flow of data. Hence, the quantitative data collection criteria were followed. Each data method has its own form (survey). The researchers and four coordinators responded to participants' queries. All surveys were then collected, organised, and analysed.

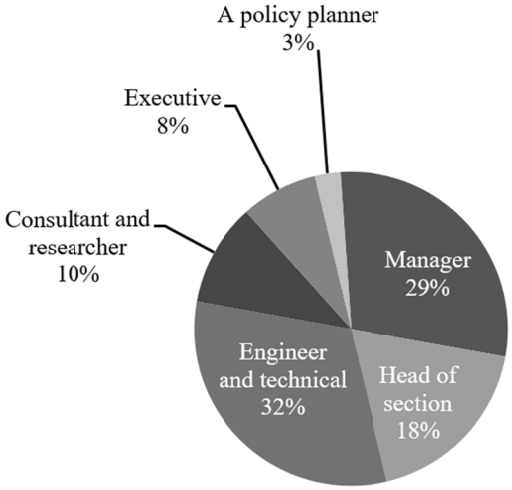

Figure 5. The demographic classification of the study participants

In this section, the sample size (n = 42) will be justified. For quantitative studies, Roscoe et al. (1975) stated that more 30 and less than 500 participants were acceptable for most studies. Particularly, with the PLS approach, a sample size of 20 to 100 is suitable (Chin & Newsted, 1999). The PLS approach was applied in the present study. In addition, the reliability analysis of the quantitative data proved the sample size was large enough (Table 2).

For qualitative studies, particularly in our case (grounded theory), Morse (1994) stated that 30 to 50 interviews were sufficient. However, Marshall et al. (2013) reviewed the qualitative sample size in a wide variety of studies, particularly in grounded theory studies, and found that fewer than 40 interviews (even 20 to 30) were suitable. This notion was consistent with Creswell (1998).

6.2 Quantitative and Qualitative Questionnaire Design

We applied the quantitative and qualitative questionnaire items according to the scientific methodological approaches. Because the current study is within the governmental domain, we obtained the quantitative questionnaire items from the UAE innovation excellence criteria (Table 2).

Table 2. Quantitative study items—questions

#	Item	Variable
1	Do you have a working group (Commission—an organisational unit) that manages the innovation process in the water sector?	The innovation team
2	Do you have financial allocations for the innovation process?	Finance
3	Do you have a widespread innovation culture?	Innovation culture
4	Is the innovation value present in your organisation and adopted from all employees' levels?	Innovation culture
5	Do you have a specific system for the management of innovation documented and implemented?	System (The innovation approach)
6	Does your organisation have a plan and specific goals for innovation?	Plan and objective
7	Do you have a research process that supports the innovation (system)?	Research
8	Do you have innovative outputs?	The level of innovation outputs
9	What is the level of your satisfaction, in general, regarding the innovative process in your organisation?	The innovation process perception
10	Do innovations achieve real change and add value to the work?	The innovation added value

The quantitative method tool was a close-ended survey consisting of two main groups—Enablers and Results—with detailed items (questions) for each group. A list of 10 items was designed for the questionnaire. The questionnaire used a five-point Likert scale (strongly disagree = 1, disagree = 2, neutral = 3, agree = 4, and strongly agree = 5; Norman, 2010).

The qualitative questionnaire was designed as an open-ended survey consisting of four questions. These four aspects represent the strengths, weaknesses, opportunities, and threats (SWOT). SWOT is used in firms and classrooms to distil fragmentary facts and figures into concise depictions of the strategic landscape (Mintzberg, 1994; Valentin, 2005). Each participant was asked to fill out five ideas for each qualitative question (for example, five ideas for the strengths aspect).

6.3 Quantitative Analysis

As mentioned before (theoretical foundation), the quantitative conceptual model strengthens the quantitative inputs in the mixed-methods analysis. This, in turn, (modelling the criteria) improves the understanding of the process related to the present study (Bertrand & Fransoo, 2002).

We analysed the quantitative data according to PLS-SEM. SEM refers to a diverse set of mathematical models, computer algorithms, and statistical methods that fit networks of variables to data (Kaplan, 2007). In recent years SEM use has grown enormously.

6.4 Qualitative Analysis

We collected data via the study questionnaire (hard copy) and then filed them electronically. Excel sheets served as the database of the qualitative study data. An accurate classification was applied to facilitate the data analysis. The analysis process started with coding data and then categorising it in the form of titles (themes). Themes were prioritised according to the repetition of codes. SWOT aspects were coloured to give an advanced understanding of each theme (Table 5). The colouring process gives an indicator of the health status of each theme. Hence it can aid with deciding the priority of the themes through additional explanations. This idea is a fruitful qualitative (strategic) approach applied by the Francophone Institute of Applied Studies in Systemics (www.ifeas.eu).

6.5 Mixed-Methods Analysis

We applied a series of precise and conscious stages during the integration of the findings, which are characterised by documentation and permanent evaluation (Rovai et al., 2013). In brief, the convergence coding matrix and triangulation analysis protocol served as the tangible base of the mixed-methods analysis. A convergence coding matrix is a specific merging tool that supports researchers to merge data (or themes) in a sequence to obtain meta-themes (Farmer et al., 2006; O'Cathain et al., 2010). The triangulation protocol is a directive concept of analysing quantitative and qualitative results (Farmer et al., 2006; O'Cathain et al., 2010).

Both concepts facilitate judging the degree of uniformity (agreement, partial agreement, silence and dissonance) between quantitative variables and qualitative themes (Farmer et al., 2006). All in all, these approaches (integration and analysing techniques) enhance the transparency of mixing findings (O'Cathain et al., 2010). However, flexibility and relativity must be considered in scientific research (Willig, 2013).

We created two tables to finalise and justify the ultimate result (meta-themes). Table 6 represents the convergent coding matrix, followed by Table 7, the triangulation analysis process, which made further justifications of the

last selected meta-themes. The current research applied a unique addition analysis to the findings. It is considered a priority of the variables and themes, which facilitates more comprehension of the convergent process.

To acquire more dimensions for the study's qualitative grounded theory, we included a supportive model: the balances scorecard model (BSC). Nielsen and Nielsen (2015) stated that BSC is one of the most comprehensive tools for decision-making (strategic and operation), and the demand for its application is increasing. This model reorganises the themes obtained from the qualitative analysis. It reimagined the grounded theory into four levels. This sequenced the study themes in an advanced related component (Figure 12).

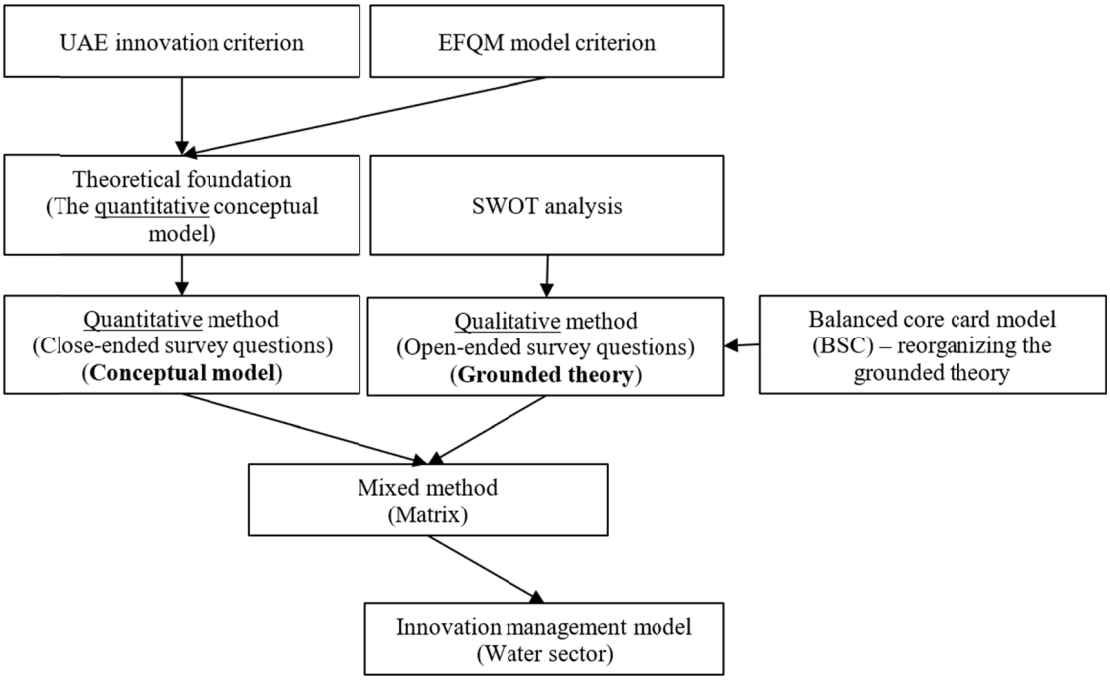

Figure 6. The general flow of the methodology

7. Results

The study consists of three types of results: quantitative, qualitative, and mixed-methods results. However, both quantitative and qualitative results are inputs for the major outputs (mixed-methods results).

7.1 Quantitative Findings

The quantitative results consist of the practical and the theoretical results. Practical results provide a tangible understanding for practitioners, particularly governmental innovation directors and technical water managers. Theoretical results consist of the theoretical base for researchers, related mainly to the innovation modelling.

7.1.1 Quantitative Practical Findings

Most of the practical aspects are related to the managerial situation (practical contributions). This part is specified for practitioners and managers. It concentrates on presenting the level of innovation in a tangible result, which urges future improvement (Table 3, Figures 7 and 8). We calculated the percentages in all results tables by considering the mean value of 3 as 60%.

Table 3. The practical level of innovation in the water sector in the UAE

Main Variables (Enablers)	Percentage	SD	Item #
The innovation team	47	1.3	1
Finance	44	1.2	2
Innovation culture	51	1.2	3 & 4
System (innovation approach)	35	1.0	5
Plan and objective	47	1.2	6
Research	39	1.1	7
Average % (Enablers)	**44**		
The level of innovation outputs	50	1.3	8
The innovation process perception	46	1.2	9
The innovation added value	54	1.2	10
Average % (Results)	**50**		
General average %	**47**		

In general, the level of innovation is traditionally considered low (47%). This general average has a different view from specialists, so it needs to be standardised. However, it hints at a low innovation level, urging the water sector to use better innovation management.

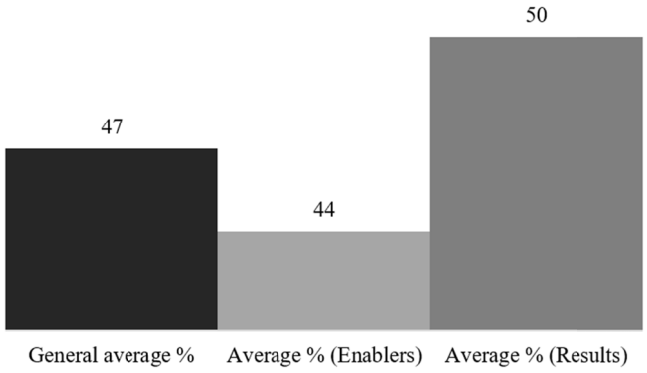

Figure 7. A comparison between the 'Enablers' and the 'Results' of the innovation process in the water sector

Both Figures 7 and 8 help managers in the water sector prioritise the innovation variables. For instance, it shows the weakest aspect of innovation management is that the innovation system counts as only 35%. Nevertheless, the theoretical results have to be considered against future improvements.

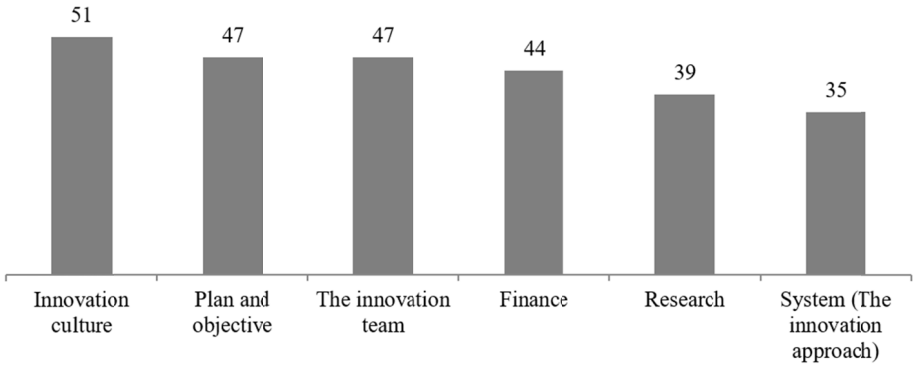

Figure 8. The level of the innovation 'Enablers' in the water sector (sorted by priority)

Figure 9 reflects that the innovation management results must be improved by strengthening innovation initiatives. Transparent and effective ideas management should be at the core of innovation improvement.

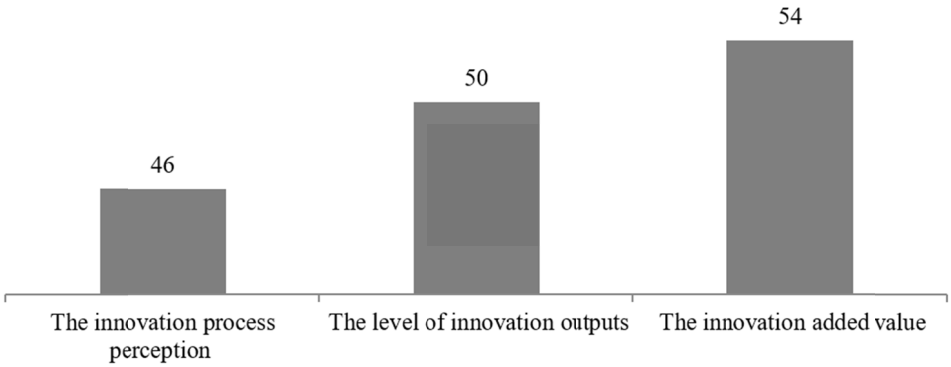

Figure 9. The level of the innovation 'Results' in the water sector (sorted by its priority)

7.1.2 Quantitative Theoretical Findings

The theoretical aspect represents the philosophical part of this study. It represents mainly the status of the relationship between the study variables. In this case, it is not important to go deep into the detailed statistical indicator. Thus, the quantitative conceptual model represents just one hypothesis instead of being separate parts (several hypotheses). The main aim is to achieve the minimum statistical requirement to reflect the rigidity of the quantitative study model. Table 4 shows the fulfilment of the main statistical indicators. It proves the soundness of data (reliability and validity) and the convenience of the study model fit. Generally, the results satisfy the required standard (Table 4). The model fit examines the suitability of the study's conceptual model for empirical data (Hair et al., 2016).

Table 4. Study data reliability and validity and model fit

	Cronbach's alpha	rtho _ A	Composite reliability	Average variance extract (AVE)	Model fit (NFI)
Enabler		1.000			0.911
Result	0.847	0.858	0.907	0.766	
Threshold	> 0.70	> 0.70	> 0.70	> 0.70	> 0.90
Status	Accepted	Accepted	Accepted	Accepted	Accepted

Source: Barclay et al., 1995; Fornell & Larcker, 1981; Hair et al., 2010, 2011, 2016, 2017.

The quantitative study hypothesis was thus accepted (t value = 26.6, p = 0.000). Therefore, the innovation enablers influence the innovation results, with path coefficient = 0.888 and R^2 = 0.788. This showed the quantitative study model was proven quantitatively (statistically) through the consistency of the governmental innovation indicators. Thus, this model could be utilized as an input for the mixed-methods phase (Figure 10).

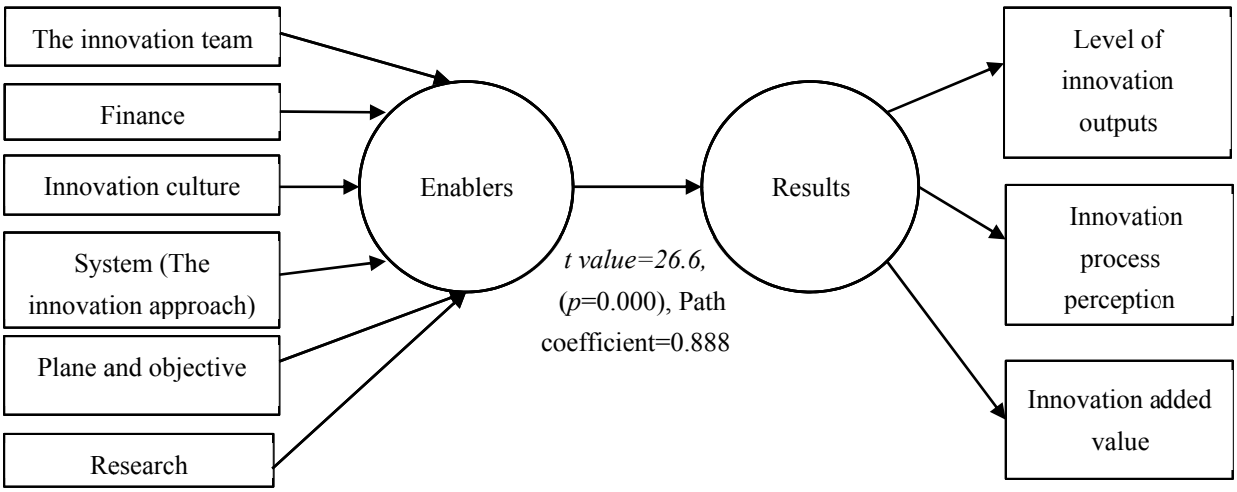

Figure 10. The study quantitative proposed model (framework) results

7.2 Qualitative Findings

The qualitative findings represent the most important themes that concerned the leaders and experts in the water sector. It shows which priorities in the future the water sector should focus on (see Table 5/Figure 11).

Table 5. Analysis of qualitative themes

Main themes	Budget and incentives	Managerial regulations and legislation	Education and awareness	Techni -ques	Leader -ship	Strategy and policy	Human resources	Data, studies, and research	Partnerships
Strength (S) Blue	16	8	12	18	25	8	13	4	6
Opportunity (O) Green	16	12	22	7	6	15	9	7	12
Weakness (W) Yellow	15	27	20	19	11	5	10	20	6
Threats (T) Orange	21	17	9	16	5	15	3	0	2
Total – Repetition	**68**	**64**	**63**	**60**	**47**	**43**	**35**	**31**	**26**
	Highest priorities ↑								Lowest priorities ↓

Note. The number in the table reflects the priorities, which are represented by the repetition of study codes.

Referring to Table 5 and Figure 11, the most fundamental themes were the first four themes because of their high repetition: ‘budget and incentives’, ‘managerial regulations and legislation’, ‘education and awareness’, and ‘techniques’. The most minor themes are considered less important compared with the first four. However, Figure 11 advanced the priorities aspect. It describes the health status of each theme. For instance, the ‘managerial regulations and legislation’ theme is unhealthy. The yellow and orange colours are higher than the green and blue colours, which reflects that the negative outweighs the positive aspect. Thus, ‘managerial regulations’ would have higher priority than ‘budget and incentives’. This shows this field (managerial regulations) will face difficulties when exerting efforts to develop it in the future. Generally, these gestures are useful for managers and practitioners if they intend to apply this data in the future.

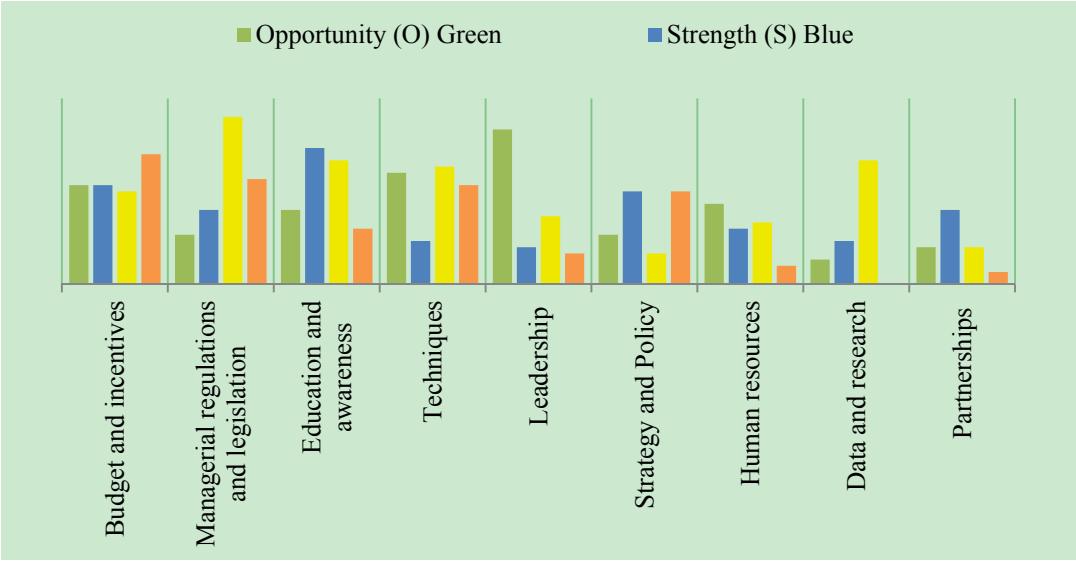

Figure 11. Analysis of ‘Main Themes’, according to the repetition of ‘Coloured SWOT’

The BSC is considered an underpinning model in this study. It aids with understanding the innovation process by enhancing the organisation of the qualitative themes in terms of the public sector circumstances. All adjustment procedures relied on Kaplan’s (1999) recommendations. The main adjustment was the exclusion of the ‘money’ component. Alternatively, the ‘customer’ component was stated as the highest priority. The customer component

represents ‘community-country results’, which is considered the major purpose of water management in the UAE in the BSC model. The ‘learning and growth’ component was slightly adjusted by adding the term ‘enablers’, relating to the subject of this study. Figure 12 shows the influence of BSC on the study themes.

Integration of BSC with SWOT is an approach applied by some institutions (Kaplan & Norton, 2008). As a result of subjecting the study themes to the BSC model, many ideas were anchored. The BSC model raised an additive component mentioned as the ‘innovation process’, which served as an operational enabler, giving a comprehensive meaning to the cause-and-effect concept. Lastly, the BSC built a clear analysis of each component’s dynamic (horizontal) effect instead of dealing with it as a vertical component.

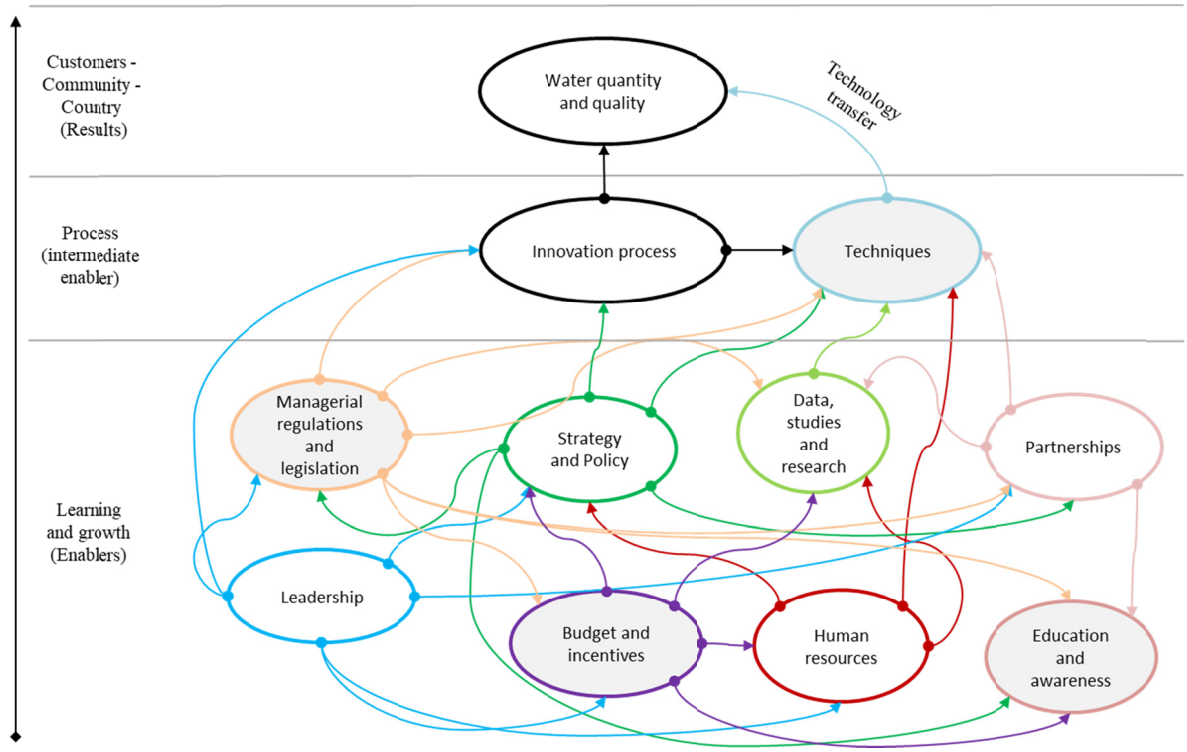

Figure 12. Study grounded theory analysis obtained via qualitative findings and BSC

Note. The ‘main qualitative themes’ are reorganized according to BSC concept. It expressed the number of arrows (effects) from each variable. This enables the practitioners and researchers to reorganize and advance the theme priorities.

7.3 Mixed-Methods Results

The combining (mixing findings) phase is the main product of the current study. First, we applied a purposeful matrix to clarify the relations and the gaps that emerged from the crossing process of the quantitative and the qualitative studies (Table 6). Then, in Table 7, we further analysed the selected meta-themes.

Table 6. Convergent coding—Mixed-methods matrix (combining quantitative and qualitative findings)

		Qualitative (themes)								
	Main themes	Budget and incentives	Managerial regulations and legislation	Education and awareness	Techniques	Leadership	Strategy and policy	Human resources	Data and research	Partnerships
Quantitative (variables)	The innovation team							✓		
	Finance	✓✓								
	Innovation culture			✓						
	System (The innovation approach)		✓				✓			
	Plan and objective						✓✓			
	Research								✓✓	
	Level of innovation outputs									
	Innovation process perception									
	Innovation added value									

Note. All themes and variables were listed according to their priority. Farmer et al., 2006 and O'Cathain et al., 2010, directions were followed. The symbol (✓✓) = agreement, (✓) = partial agreement, grey columns and rows = silence or dissonance (did not exist in the data).

When combining the 'qualitative themes' with the 'quantitative variables', six components were merged. Three themes and three variables did not match. As a result of crossing the qualitative themes with the quantitative variables, we obtained 12 components, as expressed in Table 7.

Table 7. Triangulation protocol (analysing quantitative and qualitative findings)

#	Component 1 – Qualitative 'themes'	Component 2 – Quantitative 'variable'	Matched	Unmatched	Final components (**Meta-themes**)	Number of dimensions	Type of component (Enabler: E/ Result: R)	Nature of adjustment
1	Managerial regulations and legislation	System (The innovation approach)	✓		Innovation system and legislation	2	E	According to the detailed qualitative data, the 'managerial regulations' could be changed to 'innovation system'. The innovation system has a profound meaning in this case.
2	Data and research	Research	✓		Data and Research	1	E	Research is structured data; it is kept here separately to distinguish between it and the common data perspective. It is recommended here to add another dimension named knowledge management; however, it should be justified.
3	Budget and incentives	Finance	✓		Finance and incentives	2	E	The term 'Finance' has a holistic meaning against the term 'Budget'. Hence it was preferred in this case. Incentives were added because of their remarkable existence in the data.
4	Innovation process perception			✓	Innovation subjective results	1	R	These components were slightly adjusted to give a better representation of this domain. Subjective results represent process perceptions.
5	Human resources	The innovation team	✓		Human resources Executive innovation team	1 1	E E	The human resources and executive innovation team have different duties and behaviour regarding innovation. Thus, they should be separated. The team is the 'owner', and the human resources is the 'implementer'.
6	Strategy and policy	Plan and objective	✓		Innovation strategy (planning)	2	E	The policy is embedded within the 'innovation system and legislation' component; thus, it was excluded. The planning is represented by 'strategy'. However, it was included in parentheses, to give an execution meaning.
7	Level of innovation outputs			✓	Innovation objectives results		R	Both components have a reflective interchangeable relation.
8	Innovation added value			✓				
9	Education and awareness	Innovation culture	✓		Innovation culture (human resources and community)	2		'Education and awareness' are one of the pillars of 'Innovation culture'. Therefore, 'culture' would represent all of them. According to the study data, 'culture' is related to both the human resources in the institution and the external customers, mainly the community.
10	Techniques			✓	Innovative techniques		R	Using 'innovative techniques' instead of 'techniques' is more relative to our case (innovation).
11	Leadership			✓	Leadership		E	No adjustment.
12	Partnerships			✓	Partnerships		E	No adjustment.

Note. 'Number of dimensions' is the detailed component (subtitles) under each component. The grey column showing the final components (meta-themes) emerged from the study.

Source of triangulation protocol table: Farmer et al., 2006; Heslehurst et al., 2015.

Figure 13 embodies the main purpose of this study. It responds directly to the main study question.

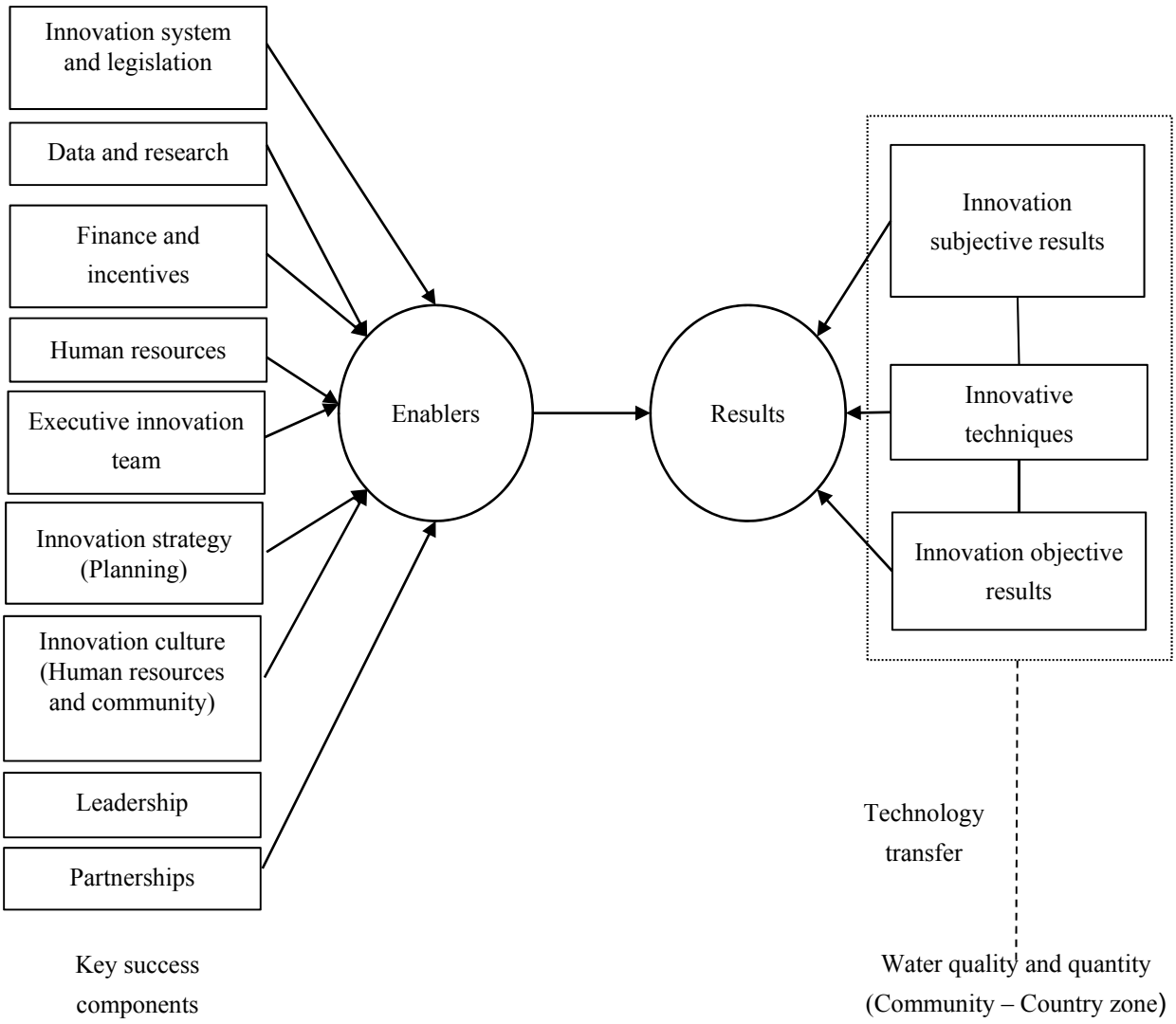

Figure 13. UAE water innovation model

Note. The ultimate targeted model of the current study consists of 12 meta-themes (9 as enablers and 3 as results). Water quality and quantity reframes the 'Innovation objective results'. It is considered the highest purpose of the water innovation process. Words within parentheses give an additional dimension for the theme. This ensures users will avoid any misunderstanding of the model while dealing with the model details.

8. The Executive Logic of the UAE Water Innovation Model

When using this model (Figure 13), it is necessary to visualise three interrelated angles, (1) the team (the leader of innovation operations and projects), (2) human resources in the water institutions (the implementer or the transformer), and (3) the community (the adopter of innovative ideas). The model indicates that innovative ideas are an overriding expression of 'innovation techniques'. Accordingly, the goal of this model is to transfer applications. It indicates adopting innovative technologies from the community for a higher purpose, which is to achieve an adequate quantity and high quality of water resources. Therefore, the holistic formulation expressed in this model is highly effective for specific enablers through the innovation management team and human resources working in the water sector to transfer, apply, and adopt innovative technologies from the community, which ultimately will achieve water availability and quality. The term 'technology transfer' has deep origins in the agricultural extension school and many other fields around the world, so we recommend referring to that valuable domain (Bozeman, 2000; Kuijpers & Swinnen, 2016).

9. Discussions and Recommendations

The UAE water innovation model could reframe the direction of water strategies by applying focused concerns

(indicators) instead of general or randomised indicators. This study is the first mixed-methods analysis applied within the scope of innovation management in the water sector in the UAE; it is recommended to add this base knowledge to advanced structured research in the future (reassociate its themes). This can be done through two approaches (1) a deep descriptive discussion of a reassociation of the model; the BSC model presented in this study would be the base of this discussion, and (2) a quantitative study based on the present model meta-themes, with an extensive research sample size to reexamine the significance and strength of the meta-themes relationship. Both approaches are a semi-final complement to the UAE water innovation model development.

10. Managerial Implications

The most fundamental implication of the UAE water innovation model is its advanced ability to objectively grade the innovation level in the relative sector (it could be one of the guidant of a national water award). This model could be a base for a holistic questionnaire to evaluate the innovation process.

This study strongly indicated the centrality of the innovation management team (committee). It is a pivotal element that affects all variables of the innovation model. Selecting this committee carefully, with accurate specification, is the magic formula for the success of the innovation process. In the case of future development of this innovation model, we suggest placing this committee at the forefront of the model and with a correlation of all meta-themes. Therefore, institutions leaders should avoid giving attention to the technical aspects alone or neglecting the importance of the human aspects (social and psychological aspects). Amabile (1983) pointed out that the human aspects are central to the innovation process.

11. Study Limitations

Even though this research has compiled reliable evidence, it is important to contribute and extend its knowledge. There is a need to refer to specialised theories and models within the domain of innovation. In addition, the questionnaire could be applied to a large number of 100 (or more) water sector participants. Having a confirmatory study with maximum sample size is preferable in modelling (Roberts et al., 2012). For that reason, more replicated questionnaire items are preferable. It is also preferable that two researchers work together during triangulation (Farmer et al., 2006). In the current study, this criterion was missing. However, a sophisticated convergent and analysis matrix would mitigate this defect.

12. Conclusion

The UAE is encountering a scarcity of water resources. It is counting on innovation management to be the rescuer of water challenges. In that context, there is a lack of a managerial framework. Therefore, the aim of the current study was to build up a managerial model for water innovation management. Ultimately, we built a holistic framework: The UAE water innovation model, consisting of 12 components (meta-themes). We strongly recommend this model be adopted as the main guide for innovation management and strategy in the water public sector institutions. Technology transfer is one of the fundamental tools to convey innovative techniques from institutions to the community zone. Globally, this model could be a significant contribution, and it would suit any country in the world with a similar environment to the UAE.

Acknowledgements

The researchers are thankful to the Ministry of Energy and Infrastructure in the UAE for facilitating this study. We are grateful to all water institutions for participating and adding their valuable information to this study, including the Ministry of Environment and Climate Change, all municipalities; Etihad water and electricity (previously the FEWA), the local authority of water and electricity (DEWA, ADWEA, and SEWA), sewerage entities, PMO; and the Ministry of Industry and Advanced Technology.

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