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Abstract:	

Unlocking the Potential: A Study on the role of Operational Excellence in Oman's Energy Sector

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Purpose: Operational Excellence (OpEx) is a proven philosophy focusing on continuous improvement in processes and systems for superior performance and efficiency. It plays a crucial role in the energy sector, acting as a catalyst for safety, customer satisfaction, sustainability, and competitiveness. This research assesses OpEx methodologies in Oman's energy sector, examining methods, approaches, motivations, and sustainability.

Methodology: This study applies qualitative analysis methodology, involving interviews with 18 industry experts, from the energy sector in a sizable energy country.

Findings: The analysis revealed a growing demand, particularly in the oil and gas industry, driven by emerging business needs. Qualitative data analysis has identified 10 themes such as implemented methodologies, motivation drivers, deployment approaches, sustainability factors, benefits, and challenges. Additionally, new themes emerged, including influencers to start OpEx, resource requirements, enablers for successful OpEx, and system.

Implications These findings contribute to understanding OpEx dynamics in the Omani energy sector, offering valuable insights for effective utilization and organizational goal achievement. Furthermore, the study offers valuable insights on how to effectively employ OpEx initiatives in the energy sector to achieve their goals and create value. It is addressing the lack of knowledge, offers a framework for successful OpEx implementation, bridging the theory-practice gap and providing insights for optimal utilization.

Originality: This is the first empirical study on assessing OpEx methodologies in the energy sector, and therefore it serves as a foundation for many future studies. The study provides a theoretical foundation for the OpEx methodologies in terms of organizational readiness for successful OpEx implementation.

limitations: This research was limited to Oman and the findings drawn from Omani energy companies may have limited applicability to energy companies in other regions. Therefore, if these findings were to be used, the validation of the findings in relation to other countries should be conducted, to ensure the validity of the context and outcome.

Keywords: Operational Excellence; Energy Sector; Qualitative Data Analysis; Lean; Six-Sigma; Agile; Process Improvement.

1. Introduction

Population growth, rising waste generation, changing regulation, higher operation costs, and subpar operational performance have been major challenges plaguing the energy sector (Kumar, 2023). In addition, implementing a carbon emissions tax, diverse environmental policies, and the need for public acceptance of changes in energy usage is a reliable means of expediting the decarbonisation process (Badakhsh and Bhagavathy, 2024). To effectively address these, it is recommended that operational excellence (OpEx) methodologies – such as Lean and Six Sigma to businesses strategy can be implemented (Gholami et al., 2021).

The concept of 'operational excellence' or OpEx refers to achieving high performance within an organisation by optimising existing resources towards achieving superior quality and efficiency across all business processes (Found et al., 2018). OpEx aims to execute business operations in a streamlined and effective manner, enabling the organisation to overcome complexity and maintain competitive advantage. This is demonstrated through reduced operating risks, lower costs, increased revenue and the creation of value for customers and shareholders (Soto, 2013). Some important OpEx methodologies – such as Lean, Six Sigma, Lean Six Sigma (LSS), Kaizen and Agile – serve as the foundation for various industries and businesses (Sony, 2019a). These improvement methodologies encompass a range of tools and techniques that guide the execution of processes and conduct comprehensive analyses to optimise value generation in any given period (McDermott et al., 2021).

Although OpEx, particularly in the form of LSS, has gained significant acceptance and implementation in certain industrial sectors like manufacturing, its adoption in other sectors such as financial services and energy is still evolving (Madhani, 2021). In the energy sector specifically, there are limited but noteworthy practical examples and benefits associated with OpEx. For instance, the implementation of LSS in this sector has resulted in a targeted improvement of 20% (Bloj et al., 2020). Through the integration of sustainability practices with OpEx strategies, energy organisations have realised significant achievements, including reductions in resource consumption ranging from 20% to 40% and cost savings ranging from 7% to 12% (Cherrafi et al., 2017).

Singh and Rathi (2019b) conducted a review of OpEx methodologies and found that the energy sector generally lags behind other industries in adopting the same. They noted that operational excellence, often referred to as operational effectiveness and process improvements in the manufacturing sector, has not been conceptualised and implemented as much in the energy sector which is a dynamic sector (Egerer et al., 2024) . They recommended further research to identify the specific barriers in this regard. The OpEx model and concept usually align company's vision for delivering value through OpEx methodologies, tools, and system with partners from people and technology. A successful implementation of OpEx uses Continuous Improvement (CI), leadership, and change management to direct towards executing the strategy (Swarnakar et al., 2021).

This research paper aims to enhance the limited empirical understanding of OpEx methodology and implementation in the energy sector. The following research questions (RQs) were framed for this study:

(RQ1) Which Operational Excellence (OpEx) methodologies are predominantly utilized in the energy sector?

(RQ2) What factors motivates the adoption of OpEx methodologies within the energy sector?

(RQ3) What are the prevalent approaches employed for the implementation of OpEx methodologies in the energy sector?

(RQ4) How do organizations in the energy sector ensure the sustainability of their Operational Excellence initiatives?

Additionally, this work presents an innovative and strategic framework for fostering cultural readiness and ensuring robust implementation as well as long-term sustainability of OpEx in the energy industry. This work holds significant potential for generating substantial value for energy companies globally and in the Middle East region. The research outcomes will empower leaders and managers to make informed decisions regarding their business operations.

The rest of the paper is organised as follows: section 2 presents a review of the literature on OpEx in energy sector by identifying gaps and limitations. Section 3 discusses the methodology of the present study; it also highlights the data collection and analyses it. Section 4 presents the findings of the study, and the implications, limitations and future research directions are discussed in section 5. Section 6 offers conclusions.

2. Literature Review

2.1. OpEx Methodologies

OpEx's evolution, drastically differs from Total Quality Management (TQM) and quality management (Jaeger et al., 2014). Some authors suggest that TQM was the closest approach to OpEx available at that time, as it incorporated similar efforts and approaches (Antony et al., 2017). However, broadly speaking, academics and experts in this field have spent their time building knowledge (Jaeger et al., 2014). There have been arguments that OpEx has evolved to replace business improvement teams with Lean, Six Sigma and Continuous Improvement (Found et al., 2018). OpEx was designed for tangible improvements, such as cost-saving or business growth, as opposed to customer satisfaction and culture change alone without measurement metrics as in the case of TQM. OpEx brings a formal approach and methodology along with its numerous tools. TQM, on the other hand, lacks essential infrastructure such as resources, budgets, project selection and reporting systems; meanwhile, OpEx preserves a robust infrastructure (Antony et al., 2017). In the present era, businesses must embrace Quality, Continuous Improvement, Lean, Agile and other methodologies in order to prosper and stay competitive. For OpEx to succeed, a theoretical framework is required to provide a deep understanding of the conceptual model (Found et al., 2018).

2.2. OpEx Methodologies in the Energy Sector

In today's fiercely competitive energy sector, maintaining a competitive edge necessitates a relentless pursuit of optimization initiatives. OpEx methodologies are used in energy sector, particularly in the oil and gas energy industry over the last 10 years. It is also observed that, the key OpEx methodologies that were applied in the energy sector includes Lean, Six Sigma, LSS and limited use of Agile and Kaizen (Al Zaabi et al., 2022). A systematic literature review published in 2022 by Al Zaabi et al., (2022) indicates that

the Lean OpEx methodology is the most used one in the energy sector and the application of Lean principles, procedures, practices, and improvement is widely explored in most classes of the energy sector, specifically oil and gas (de Mattos Nascimento et al., 2019). Another study found that by meticulously following Lean Six Sigma's structured approach, the energy company not only surpassed its predefined targets but also achieved a remarkable enhancement in actualization rates, soaring from 2.6% to an impressive 20% within a mere three-month period(Bloj *et al.*, 2020).

The next popular OpEx methodology is the Six Sigma, a data-driven OpEx methodology gaining acceptability in most energy classes such as oil and gas, wind, energy, power, and solar (Yazdi et al., 2021). A combination of Lean and SS, LSS, a hybrid methodology, is accepted as a unified methodology for OpEx, mainly in the oil and gas class, and only one publication was found to discuss it in other classes (Ratnayake and Chaudry, 2017). The utilization of LSS proves instrumental across various facets of electricity energy operations, including generation, transmission, and distribution. Its application serves to eradicate inefficiencies while concurrently enhancing customer satisfaction, profitability, and other key performance indicators. Furthermore, the triumphs documented in all five cases underscore the sustained economic advantages derived by organizations through the implementation of LSS methodologies (Sony,2019).

The key motivation factors for implementing OpEx methodologies include improving operational efficiency, gaining competitive advantage, transforming organisational culture, improving service quality, and controlling costs (Al Wahaybi et al., 2021). The benefits of OpEx methodologies were classified into operational improvements such as increased efficiency and leadership, and strategic advantages such as gaining a competitive edge and contributing to the circular economy (Perey et al., 2018).

There are limited publications and theories focusing on the aspects of OpEx specific approach to the energy sector, but a common observation was all the existing implications addressed only a specific methodology or case study, and none of the publications investigate a complete OpEx methodology approach (Yazdi et al., 2021). These approaches did not address the full range of energy industry and they all focus on one specific class of energy sector. (de Mattos Nascimento et al., 2019).

The key sustainability factors for successful OpEx methodologies were; first, effective project sponsorship (Ho et al., 2008). Secondly, training and skills, which might be expensive and costly for some organizations, are a key factor for the sustainability of OpEx. (Laureani and Antony, 2012). Thirdly, good project selection leads to sustainable deployment (Su and Chou, 2008). Antony, 2022, affirm, "Alignment between the methodologies and strategic priority of the organisation is necessary". In addition, strong human and financial resources (Aboelmaged, 2011). Finally, acceptance to change or good change management practices in the work culture (Antony et al., 2012).

2.3. Research Gaps

Key gaps identified in the literature on OpEx in the energy sector encompass:

(1) The current body of literature underscores the widespread implementation of Lean and Lean Six Sigma compared to other operational excellence methodologies. However, empirical research papers specifically addressing OpEx methodologies in the energy sector are limited (Shou et al., 2021, Shokri, 2017).

(2) Generally, OpEx methodologies have predominantly been applied to enhance non-energy sectors, with limited studies exploring their application in the energy sector (Albliwi, 2017, Sony, 2019b). Thus, the authors propose an investigation into the motivational factors that drive the energy sector to embrace OpEx methodologies.

(3) A notable observation is the lack of a standardized approach for OpEx methodology selection among companies in the energy sector (Piya et al., 2020).

(4) The study identifies a common absence of established frameworks or guides to aid energy companies in the adoption, implementation, and maintenance of OpEx methodologies (Al Zaabi et al., 2022). Consequently, the authors recommend the development of a comprehensive roadmap to assist operations and process improvement professionals in successfully implementing and sustaining OpEx methodologies.

(5) Present research fails to integrate OpEx methodologies with advanced industry technologies like Industry 4.0 and big data, despite the demonstrated enhanced business performance in other sectors (Antony et al., 2023, Singh et al., 2023).

3. Methodology

A qualitative method was employed in this study to gain a deeper understanding of current practices on OpEx methodologies, adoption, motivation, approaches, and sustainability factors in the energy sector. The participants included CEOs, senior managers, and experts of OpEx and continuous improvement professionals from the energy sector in Oman. The semi-structured interviews consisted of both open-ended and closed-ended questions. This method was chosen to enable the author to ask follow-up questions and explore the topic further, providing more flexibility than structured interviews (Merriam and Tisdell, 2015). Furthermore, the interviewees were encouraged to openly express their perspectives and viewpoints, yielding comprehensive insights that can underscore the role of OpEx methodologies within the energy sector. Moreover, the interview findings were used to explore new themes, validate previously established themes from the literature review, and enhance the accuracy of the obtained results (Farrukh et al., 2023). Consequently, this approach facilitated better management and in-depth exploration of the literature findings, allowing for a meaningful exchange with the experts in the energy sector in Oman (Saunders et al., 2009).

3.1. Research Setting

The Semi-structure method was considered robust for generating in-depth data within qualitative research and knowledge in a question layout (Schmidt, 2004). Moreover, it supported the objective of exploring the current OpEx practices and providing appropriate solutions for the 'How' part of the RQ (Saunders et al., 2009). To achieve this, the proposed study followed Robinson (2014) practical guidelines for sampling an interview, involving four main steps: (i) define the sample universe and inclusion of participants; (ii) consider the sample size (Mengelkamp et al., 2019); (iii), select the sampling strategy; and (iv) aspects of sampling the source. However, it should be noted that conducting interviews in Oman posed challenges due to their expensive and time-consuming nature, primarily because of the interviewees' varying availabilities, the need to travel to different locations, and extensive preparation to ensure productive and informative conversations (Albliwi, 2017). As a result, the population in this research comprised CEOs, General Managers

(GMs), Leads, OpEx experts and practitioners from the Omani energy sector – individuals who possessed deep knowledge of and experience in OpEx methodologies.

Oman was selected for this research as one of the largest oil and gas producers globally and holds a substantial share in the energy sector (Indeo, 2024). Oman has notable impetus and authoritative direction in the application of OpEx within the energy sector, resulting in a plethora of publications and experiences that surpass those of other countries (Al Salmi et al., 2022, Al Shukaili et al., 2023).

The list of organisations in the Omani energy sector was obtained from the Ministry of Energy's database. Subsequently, potential companies implementing OpEx methodologies were short-listed with the assistance of ministry advisors. Organisations on the shortlist were contacted to verify if they pursued any OpEx initiatives. Other organisations were chosen by the researcher based on the information from company websites containing information about OpEx implementation. Companies without OpEx implementation initatives were excluded, ensuring adherence to the enrolment parameters. This process led to the identification of 18 potential participants represented by 14 different energy companies in Oman. The sample size of 18 participants involved in the interview is proven to be sufficient for such type of research and research question, data was saturated (Collis and Hussey, 2013; Creswell and Poth, 2013). The individuals below were contacted via phone and email, and consent forms were obtained.

3.2. Data Collection

Step 1: Select the participants, in particular the participants were purposefully chosen from the potential population, and they agreed to be part of the interviews. Participation criteria were as follows: first, the interviewee practised OpEx project(s) in the energy sector. Second, the interviewee was familiar with OpEx projects or methodologies such as Lean, Six Sigma, Agile, Kaizen and so on.

After thorough consideration of several factors, including the homogeneity of the chosen group, the study's scope, the nature of the topic, expected data quality, research design type, the nature of the four research questions, available resources and budget, time constraints, the researcher's experience in qualitative research and OpEx within the energy sector, and taking into account the supervisor's guidance, it was concluded that conducting interviews

was the most appropriate approach. Within these parameters, a total of 18 participants from 14 different companies in the energy sector were interviewed.

The participants were grouped into categories A, B, C, D, E and F for the interview questionnaire based on their roles within their respective organisations, as indicated in Table 1. Each interview lasted an average of 30 minutes, ensuring that valuable insights were obtained while also efficiently managing the time of both the participants and the researcher. All the participants were asked to sign consent before taking part in the research interview including their rights to the information, the research aims, and objectives.

Step 2: Preparing guidelines and a set of interview questions. The interviewees were asked questions related to the research objectives, with each group receiving a tailored set of questions based on the specific information and data the author sought to gather. Ahead of the interviews, all participants received a pre-read document containing the anticipated questions and essential information, ensuring a productive and smooth interaction.

Table 1: List of Interviewee, profile and classification

G	Int	Title	Industry	Typology
A	1	Chief Executive Officer	Oil & Gas	Service/Product-International
A	2	Chief Executive Officer	Oil & Gas	Service-National
A	3	Chief Executive Officer	Oil & Gas	Service/Products-National
B	4	Senior Planning & Strategy Manager	Oil & Gas	Operator-National
B	5	Senior Regulatory & Affairs Manager	Power	Supplier-Private
C	6	Technology & Renewable Manager	Renewable	Supplier-Private
D	7	OpEx Deployment Lead	Oil & Gas	Operator-National
D	8	OpEx Deployment Lead	Oil & Gas	Operator-International
D	9	OpEx Deployment Lead	Refineries	Operator-National
D	10	OpEx Methodology Expert	Oil & Gas	Operator-National
D	11	OpEx Methodology Expert	Oil & Gas	Operator-National
D	12	OpEx Methodology Expert	Oil & Gas	Operator-National
E	13	OpEx Practitioner	Oil & Gas	Operator-National
E	14	OpEx Practitioner	Refineries	Operator-National
E	15	OpEx Practitioner	Oil & Gas	Operator-International
F	16	Senior Asset Manager	Oil & Gas	Operator-International
F	17	Senior HR Manager	Oil & Gas	Operator-National
F	18	Senior Finance Manager	Oil & Gas	Operator-National

Step 3: Throughout the interview process, participants were encouraged to share their personal experiences and perspectives related to the questions. They were granted the

flexibility to steer the conversation, which facilitated the recording of comprehensive qualitative data. The author actively engaged by attentively listening, posing follow-up questions and seeking clarifications on responses. This approach enabled the author to gain profound insights into the participants' thoughts and experiences.

Step 4: Detailed notes were taken, and essential points were recorded during the interviews. Additionally, with participants' consent, the sessions were recorded using Microsoft Teams and other recording devices.

Step 5: To enhance the consistency of the collected data and prevent bias, a thorough cross-check of the quality was performed. Throughout the interviews and data analysis, the author diligently refrained from making any personal assumptions or guesses about the subject (Tufford and Newman, 2012). For ensuring validity, each interview was promptly listened to, transcribed and key findings were documented in notes. Subsequently, the voice and video recordings, along with the notes, were shared with the interviewees for their approval. All interviewees' requests were accommodated, fostering a successful and smooth interview process.

3.3. Data Analysis

All the semi-structured interviews were conducted using video (Microsoft Teams) and audio (face-to-face records). These interviews were transcribed into text and then uploaded into NVivo software for content analysis. The qualitative data obtained from the interviews was analysed using a thematic analysis method, which involved carefully reading through all the data sets and identifying patterns and meanings to establish themes. According to Braun and Clarke (2006), codes were used as concise labels highlighting important aspects in the data, while themes represented recurring patterns centred around a central organising concept (Braun and Clarke, 2006).

The analysis process followed a combination of within-case and between-case analyses (Eisenhardt, 1989) and consisted of three coding stages, as depicted in Figure 1 (Ridder, 2014). Initially, the 18 cases were individually analysed to identify descriptive and interpretative codes related to each OpEx theme, aligning with the research questions (Miles and Huberman, 1984). A concept-driven coding approach was then employed to

extract relevant data and generate the most compelling evidence (Green et al., 2007). This coding stage resulted in a list of codes associated with OpEx across the cases. Subsequently, the codes were grouped to examine cohesive patterns and shared meanings, leading to the identification of specific sub-themes/patterns of OpEx. These sub-themes were consolidated into overarching themes. Through the examination of 18 interviews involving participants from 14 distinct organizations, a set of 10 primary themes was identified. While the majority of these themes were explicated during the prior Systematic Literature Review (SLR), additional insights were revealed through the interview process.

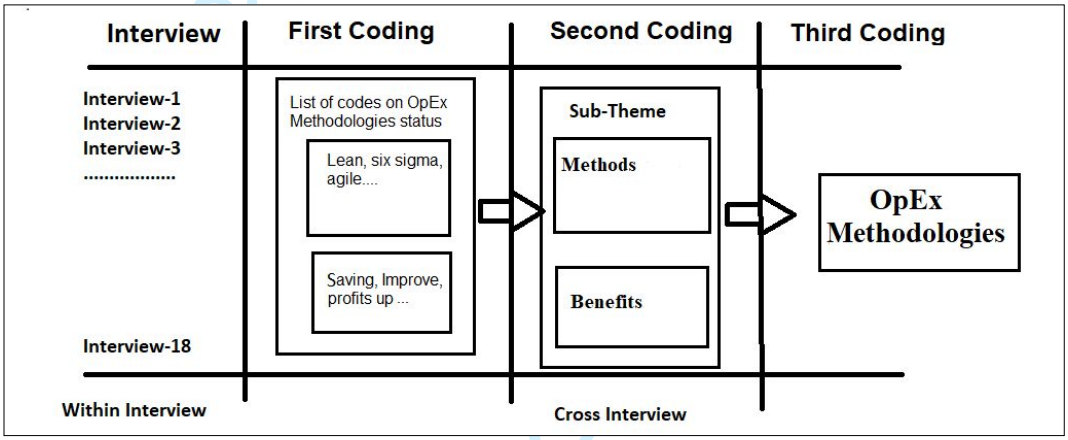

Figure 1: Process of within and cross-interview analyses (Eisenhardt, 1989)

4. Findings

4.1. Characteristic of Participants

Information was gathered via interviews involving 18 individuals engaged in OpEx projects within the energy sector in Oman. The participants were categorized into six groups: Group A comprised three CEOs, Group B included three Senior Managers, Group C featured three heads/leads responsible for deployment, Group D consisted of three OpEx experts, Group E encompassed three practitioners, and Group F involved three managers from finance, human resources, and business. Among the 18 interviewees, 14 were from the oil and gas energy sector, two from a refinery, one from the power sector and one from renewable energy. These participants represented a mix of private sector, national companies and international companies, as detailed in Table 1. Notably, OpEx methodologies were more prevalent in larger energy companies, with limited adoption in

small and medium-sized companies. The qualitative analysis of OpEx pointed to a growing popularity and increasing business needs for the application of OpEx methodologies in the energy sector in Oman, particularly within the oil and gas industry.

4.2. Extracted Themes

The main themes, along with their respective sub-themes, identified using the NVivo software, are presented in Figure 2 and Figure 3, respectively.

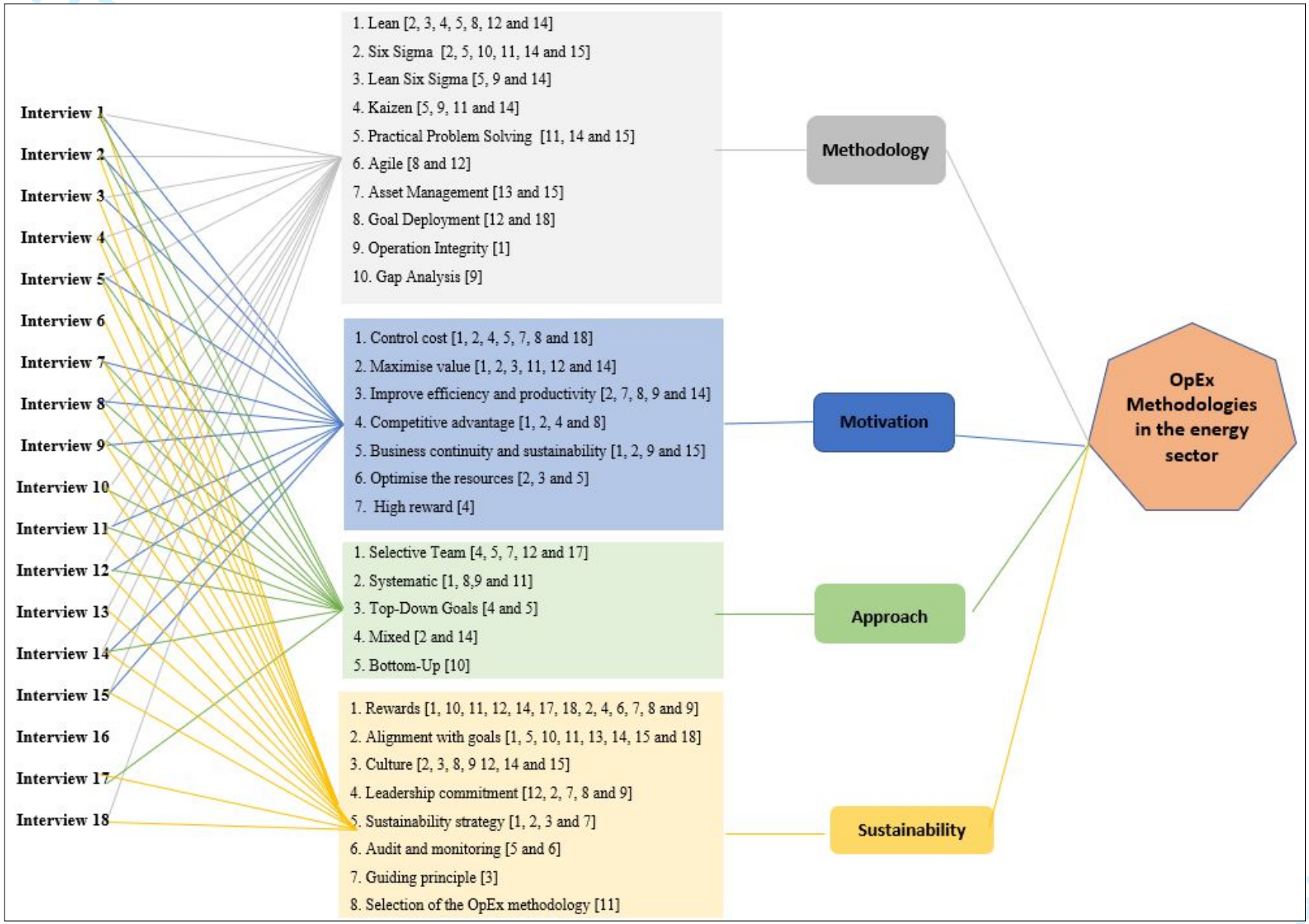
Interview 1
Interview 2
Interview 3
Interview 4
Interview 5
Interview 6
Interview 7
Interview 8
Interview 9
Interview 10
Interview 11
Interview 12
Interview 13
Interview 14
Interview 15
Interview 16
Interview 17
Interview 18
1. Lean [2, 3, 4, 5, 8, 12 and 14]
2. Six Sigma [2, 5, 10, 11, 14 and 15]
3. Lean Six Sigma [5, 9 and 14]
4. Kaizen [5, 9, 11 and 14]
5. Practical Problem Solving [11, 14 and 15]
6. Agile [8 and 12]
7. Asset Management [13 and 15]
8. Goal Deployment [12 and 18]
9. Operation Integrity [1]
10. Gap Analysis [9]
1. Control cost [1, 2, 4, 5, 7, 8 and 18]
2. Maximise value [1, 2, 3, 11, 12 and 14]
3. Improve efficiency and productivity [2, 7, 8, 9 and 14]
4. Competitive advantage [1, 2, 4 and 8]
5. Business continuity and sustainability [1, 2, 9 and 15]
6. Optimise the resources [2, 3 and 5]
7. High reward [4]
1. Selective Team [4, 5, 7, 12 and 17]
2. Systematic [1, 8,9 and 11]
3. Top-Down Goals [4 and 5]
4. Mixed [2 and 14]
5. Bottom-Up [10]
1. Rewards [1, 10, 11, 12, 14, 17, 18, 2, 4, 6, 7, 8 and 9]
2. Alignment with goals [1, 5, 10, 11, 13, 14, 15 and 18]
3. Culture [2, 3, 8, 9 12, 14 and 15]
4. Leadership commitment [12, 2, 7, 8 and 9]
5. Sustainability strategy [1, 2, 3 and 7]
6. Audit and monitoring [5 and 6]
7. Guiding principle [3]
8. Selection of the OpEx methodology [11]
Methodology
Motivation
Approach
Sustainability
OpEx Methodologies in the energy sector

Figure 2: The main themes extracted from the interviews.

The analysis of the 18 interviews revealed 10 main themes and 73 sub-themes. These encompassed methodology, approach, benefits, motivation, challenges, sustainability, system, resources, influencers, and enablers. Notably, six of these main themes were identified in existing literature, while four were newly uncovered through this study.

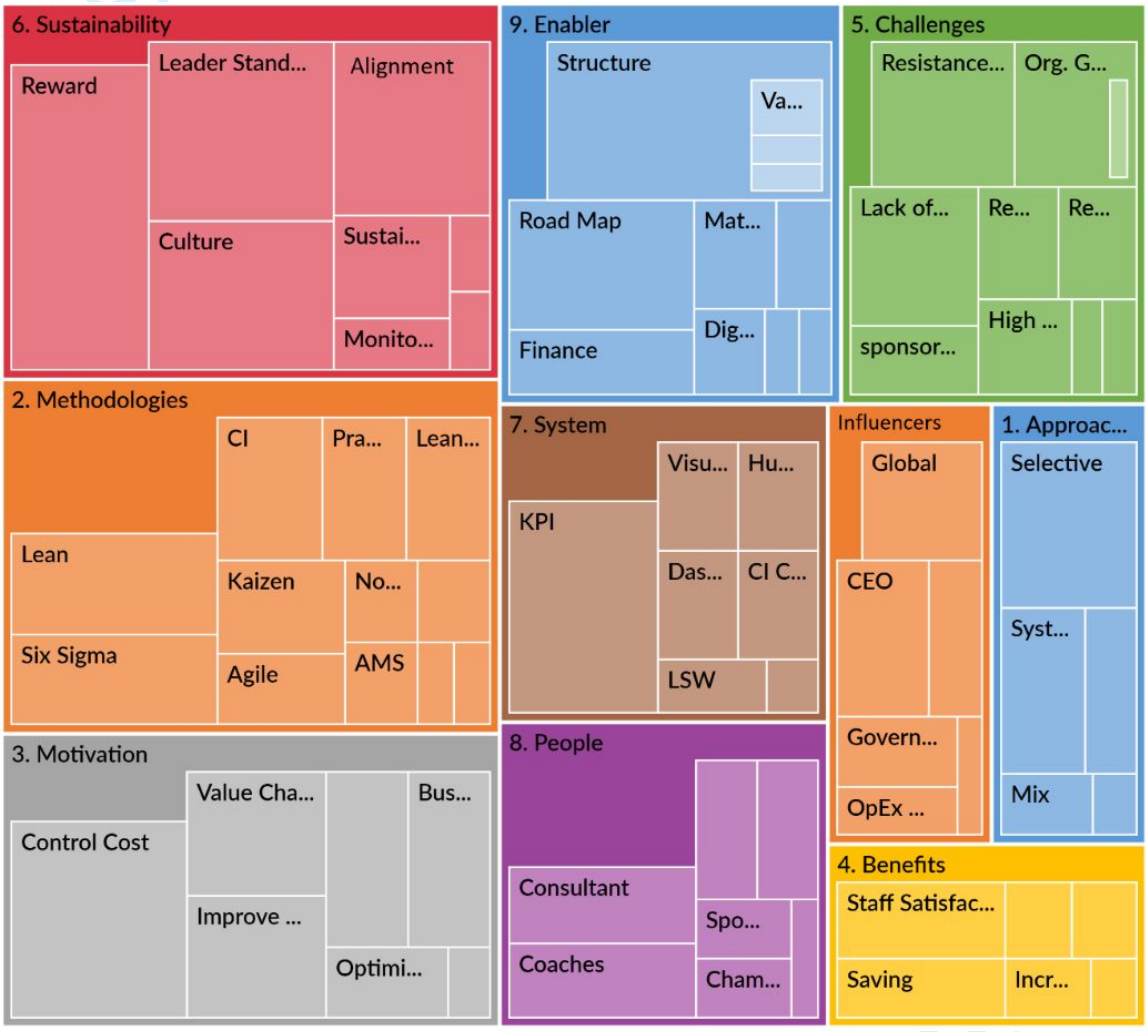

Figure 3: The sub-themes using the NVivo software.

4.3. OpEx Methodologies Adoption (RQ1)

The analysis of the data resulted in identifying key themes that served as the basis for constructing a conceptual framework, visually represented in Figure 4. This author-developed framework illustrates the existing implementation of OpEx methodologies in Oman's energy sector, addressing the first research question (RQ1).

OpEx Methodology Framework									
Type / Methods	Problem Properties		Analysis Required		Financial Benefits	Challenge	Approach	Way	Who
	Quantity	Difficulty	Time	Depth					
PPS	Many	Easy	Short	Shallow	Low	Low	Within a team	Rapid	Team leaders/ Members
Kaizen							Cross/ Top Down	Practical	Experienced KE Facilitator
Lean							Cross functional	Practical	LP Practitioner
Six Sigma							Cross functional	Advanced	Six Sigma Practitioner
Lean Six Sigma							Cross functional	Very Advanced	Lean Six Sigma Practitioner
Agile							Cross functional	Advanced	Agile Expert
AMS							Cross functional	Practical	Team leaders/ Members
Goal Deployment	Few	Hard	Long	Deep	High	High	Top Down	Practical	Focal Points

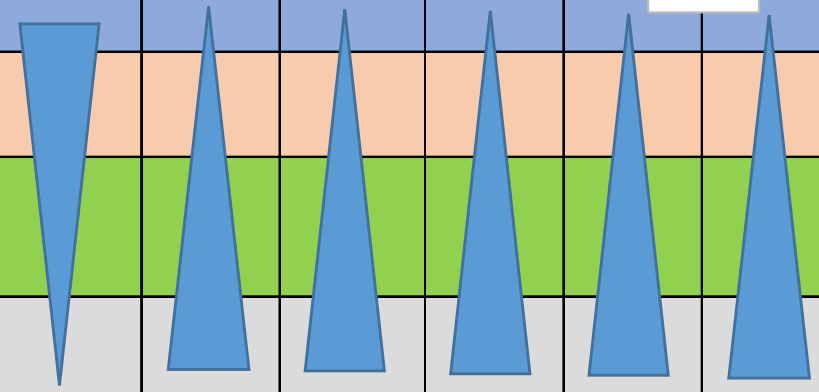

Figure 4: OpEx methodologies adoption framework

4.3.1 OpEx Methodologies Characteristics

The key OpEx methodologies cited in Table 2 include Lean methodology, which emerged as the dominant OpEx approach in the energy sector of Oman. According to interviews, participants 2, 3, 4, 5, 8, 12 and 14, Lean was perceived as a simple, easy-to-implement methodology and adds value to the business. The second most popular OpEx methodology was Six Sigma. "*We trained and certified our people on Six Sigma green and black belts to improve business performance and generate value for the business"* [11, Continuous Improvement (CI) expert]. A combination of Lean and Six Sigma was observed as the common methodologies used by participants 5, 9 and 14. "*A mix between Lean and Six Sigma tools for solving different problems focusing on removing waste from the process"* [14, CI expert]. Kaizen methodology was observed as the preferred method by interviewees 5, 9, 11 and 14 due to its simplicity and quick implementation (within a week). Agile as emerging OpEx methodology was addressed by participants 12 and 18. "*In agile ways of working, we need to come up with top priorities and deliver effectively in less time"* [12, Agile expert]. All of these methodologies were aligned with observations reported in literature (Al Zaabi et al., 2022).

Several new OpEx methodologies for the energy sector in Oman were mentioned by interviewees but were not included in the literature review (Al Zaabi et al., 2022). These methodologies include Practical Problem Solving (PPS), Asset Management System (AMS), Goal Deployment, Operation Integrity and Gap Analysis.

PPS emerged as a popular and effective methodology in the energy sector, as it offered a set of simple tools to solve oil and gas-related problems within a short timeframe. Interviewees 11, 14 and 15 recommended and utilised PPS to eliminate waste and find quick solutions for urgent issues. "*We do PPS to eliminate waste and come up with a quick solution for our rapid problems"* [15, OpEx practitioner].

An additional OpEx methodology highlighted during the interview was the Asset Management System (AMS). "*The Asset management system starts at the groundwork and gets people to understand the basics and transition for the structure to deliver on the expectation"* [13, AMS expert]. In Goal Deployment, management defines high-priority goals and cascades down to organisational teams, ensuring that actions progress at all levels

(by participants 12 and 18). The following citation was observed for Operation Integrity: "*Operation integrity is one of the common OpEx in our organization where we operate the business within an operating window with all risks managed and mentioned by the system and continuous improvement"* [1, CEO]. Gap Analysis was mentioned as a methodology used to assess the performance of business units and determine whether business requirements and objectives were being met [9, OpEx Lead].

Recent qualitative research (16 interviews) were undertaken with practitioners working in leading non-energy companies and with leading academics in Asia, Europe, Africa, North America, South America and Australia found they key OpEx methodologies are including Lean, Six Sigma, Lean Six Sigma and Agile which is similar to both the SLR finding and this work (Trakulsunti et al., 2024).

Table 2: Key OpEx methodologies applied in the energy sector in Oman.

Methodology	Description	Interviewee
Lean	Lean principles, procedures, practices, and improvement tools	2, 3, 4, 5, 8, 12 and 14
Six Sigma	An established data-driven methodology	2, 5, 10, 11, 14 and 15
Lean Six Sigma	A hybrid methodology of lean and six sigma	5, 9 and 14
Kaizen	Well-established continuous improvement methodology in the manufacturing sector	5, 9, 11 and 14
Practical Problem Solving	Root cause analysis and simple tools for problem-solving	11, 14 and 15
Agile	Emerging OpEx methodology and established in the IT sector.	8 and 12
Asset Management	A process used by a company to manage all its assets across the business	13 and 15

Goal Deployment	OpEx methodology for executing strategic goals at every level.	12 and 18
Operation Integrity	Operating the asset safely and efficiently, within the defined operating window and with all the risks controlled and managed.	1
Gap Analysis	Performance analysis method for the business.	9

4.3.2. OpEx Methodologies Benefits

Based on the interviews, implementing OpEx methodology can solve more complex problems and achieve greater financial benefits (as shown in Figure 5). In the Oman energy sector, six benefits of implementing OpEx were cited. Among these, two were operational (cost reduction and increased revenue), two were aligned with the organisational strategy (quality and delivery for competitive advantage), and two were related to leadership from a managerial perspective (people and process). The primary benefit gained by adopting OpEx was cost reduction, as cited by 4, 11, 15 and 18, closely followed by staff satisfaction (1, 2, 7, 8 and 18), safety processes and standards achieved through OpEx application (cited by 4 and 8), as well as an increase in revenue reported by participants 5 and 6. Quality and speed or agility of maturation were noted by participants 5 and 10.

The literature identifies 12 benefits of OpEx reported by users during the implementation of the methodologies and categorised them into three types: (1) operational, (2) leadership priorities and (3) strategic, which aligns with the findings from the interviews (Al Zaabi et al., 2022). However, it was observed that the total number of benefits mentioned was less than 50%, and two new benefits were identified during the interviews (improved safety and agility of maturation). Safety was the top priority in the energy sector in every country, as any accident or incident could lead to loss of life, damage to assets or the environment, and financial loss. One way of enhancing safety in the energy sector in Oman was by implementing all OpEx practices, skills, and systems to identify, assess and mitigate risks associated with each aspect of energy operations. "*Safety was one of the drivers and benefits of using the CI and OpEx in our company"* [4, GM].

The agility and ability to deliver and mature energy projects in a shorter time were among the observed benefits of applying OpEx methodologies like Agile. "*An agile concept helped us to do and deliver high-priority work in a short time and focus on operating the top priority. For example, some projects used to take six years and now we can deliver them in four years only"* [12, Agile expert].

A study on OpEx in manufacturing sector concluded that the implementation of OpEx supports the business to improve their quality, cost, delivery, production capacity, net earnings, overall savings, customer satisfaction and reduce their defects, inventory, cycle time, and machine breakdown (Swarnakar et al., 2021). This shows the similarity of the expected benefits between energy sector and other sector during the implementation of OpEx.

4.3.3. OpEx Methodologies Resourcing

This section discusses the human resources requirements for effective implementation of OpEx methodologies (as shown in Table 3) in the energy sector in Oman, following the framework presented in Figure 3. According to interviewees 4, 9, 14, 17 and 18, having a consultant or expert was considered essential at the beginning of the OpEx deployment. "*Our company hired a consultant to build the vision and road map for the OpEx deployment"* [4, Senior Manager].

Several participants mentioned in Table 4 highlighted the significance of having OpEx coach/ expert trainer within the organisation to train and develop the staff. "*I have 11 senior coaches reporting to me and their full-time job is to coach and develop staff* "[11, Expert]. The OpEx practitioner was identified as another crucial element for the successful implementation of OpEx, cited by participants 11, 4 and 6. "*Lean or Six Sigma practitioner depends on the selected methodology for the deployment has to be selected from the relevant field of the problem to solve"* [11, OpEx expert]. In participants 14 and 17, a focal point was appointed in each department to support and facilitate OpEx implementation. Additionally, each OpEx project required a champion, as mentioned by individuals 4 and 7 and a sponsor, as cited by individuals 4 and 8, with the role of supporting and enabling the OpEx project, as outlined in Table 4. Lastly, a deployment lead role was mentioned by

individual 11, as their company underwent a large transformation, leading to the assignment of an OpEx lead for each department.

Experts and human resources in the OpEx field in both academics and industry are divers and very few, which is why contributions to theory and knowledge are limited (Piya et al., 2020). This is in line with the finding from the interview as shown in table 3.

Table 3: OpEx Resourcing Model

Resource	Description of Role in the OpEx Project	Interviewee
Consultants	Offer advice and expertise to help in the execution of OpEx, manage change and solve problems	4, 9, 14, 17 and 18
Coaches	Plan and deliver OpEx activities and programmes for individuals and teams	11, 17, 7 and 8
Practitioners	Develop their OpEx skills and perform tasks or deliver projects for businesses	11, 4 and 6
Focal Points	Facilitate the communication and follow-up between a department and the central team of OpEx.	14 and 17
Champions	Highly performant and engaged employees who support others in practising OpEx.	4 and 7
Sponsors	Oversee the OpEx project and programme and is accountable for ensuring the fulfilment of the specified benefits over time	4 and 8
Deployment Lead	Responsible for detailed solution deployment planning, preparation, set-up, readiness and cutover OpEx activities	11

4.3.4. OpEx Methodologies Implementation Challenges

The most commonly cited challenge faced during the implementation of OpEx was the lack of knowledge, expertise and a clear road map. "*You know, the knowledge and*

competency of the staff on OpEx is not easy to do and you need a certain level of experience" [2, CEO]. "*The in-house capability is better and cheaper, but you don't have that option and we have to bring it from outside"* [18, CFO]. Interviewees 6, 8, 11 and 18 reported challenges related to employees' or managers' resistance to change. "*Our business is very dynamic and the front line believes and understands the change is difficult until they start to see the value of the change"* [11, OpEx expert]. This finding corresponds with existing literature, which similarly identifies resistance to change as a primary cause for OpEx initiatives encountering difficulties (Al Zaabi et al., 2022).

High implementation costs (cited by 15, 17 and 18) and the availability of resources and funds (reported by 8, 14 and 15) were key challenges in initiating OpEx implementation. Another common challenge faced by interviewees 5, 6 and 18 was the need for changes in the organisational structure. Although not commonly cited in the literature, this challenge appeared to be influenced by country regulations and external factors. "*We are in the process of major restructuring in our sector, and we don't have control over that, which makes OpEx deployment a challenge"* [6, GM].

The support and commitment of the OpEx sponsor were crucial with regard to the deployment; he/she should be on board and committed to enforcing the change (Chakravorty, 2009). "*Sometimes you may find a lack of support from leadership and sponsor, this is not because they don't see value, but it is about they have other priorities"* [2, CEO]. Interviewee 14 highlighted the challenge of selecting the right projects, as this could impact project timelines, value generation and motivation for deployment. "*Project selection is a very challenging because people will come at the beginning of the project with high energy and excitement until they get the result and if the project not adding value they will escape and never come back, which impacts the OpEx deployment reputation and sustainability"* [14, OpEx practitioner). Additionally, interviewee 2 expressed concerns about people quantification on the project, which did not add value. This indicates the importance of measuring the impact of OpEx initiatives accurately. Overall, the scale or trend of challenges faced during the implementation of OpEx methodologies is presented in Figure 5.

Some common failures and challenges observed in OpEx deployment in different industries globally are lack of effective sponsorship and training (Antony et al., 2019). Second, Poor project selection and weak alignment between the methodologies and strategic priority of the organisation (Antony et al., 2012). Finally, lack of human and financial resources in the organisation (Aboelmaged, 2011). This finding validated a theory of, there a similarity in the challenges face the OpEx deployment in energy sector compare with other sectors, but with different order.

4.4. OpEx Methodologies Motivation Drivers (RQ2)

The motivation drivers for implementing OpEx, which were addressed in research question (RQ2) and observed as one of the themes in the literature (Al Zaabi et al., 2022), included key factors that motivated companies in the energy sector to adopt OpEx. These factors were as follows: (1) enhance operational efficiency, (2) gain competitive advantage, (3) drive cultural transformation and (4) improve service quality and reduce costs (Rachman and Ratnayake, 2017, Baysan et al., 2019).

Interestingly, the author noticed that most of the drivers for OpEx adoption in the energy sector in Oman were different from those reported in the literature. While this additional data provides valuable insights for further research, it might be specific to the energy sector in Oman only.

According to a CEO, the implementation of OpEx within their organization was initiated to realize distinct strategic objectives, including the attainment of a competitive edge. "*Without OpEx you will always be behind in a very competitive market and for me I want to lead and be the top service provider"* [1, CEO]. Another CEO mentioned: "*we have deployed the OpEx in our organisation to secure our business continuity and long-term sustainability"* [2, CEO). Yet another driver that was cited was cost control, "*our operating costs are increasing, so we need something in place to control that"* [2, CEO]. Value was cited in interviews 1, 2, 3, 11, 12 and 14 as a key driver: "*if we don't have the common understating of what is the value chain of what we are trying to deliver, we will then start to create a silo and OpEx helps us to break the silos and bring everyone on the same level"* [2, CEO). A noteworthy discovery revealed that an organization was incentivized to adopt OpEx because of the favorable ratio of low investment to high rewards associated, *"it*

doesn't require budget actually to establish" [4, Manager]. The most common and key motivating factors for the OpEx methodologies deployment in the energy sector organisation in Oman are presented in Figure 5 and listed as follows:

1. Control the operation cost (1, 2, 4, 5, 7, 8 and 18)
2. Maximise value from the supply and delivery chain (1, 2, 3, 11, 12 and 14)
3. Improve the business efficiency and productivity (2, 7, 8, 9 and 14)
4. Competitive advantage (1, 2, 4 and 8)
5. Business continuity and sustainability (1, 2, 9 and 15)
6. Optimise the resources (2, 3 and 5)

Figure 5: The cited motivation drivers for OpEx in the energy sector

The new motivations (items 5 and 6) observed for OpEx in Oman's energy sector could be explained by the nature of the energy sector as a highly dynamic and constantly evolving that dealt with the upstream part of the energy industry like exploration, production, distribution and consumption of various forms of energy. The sector was highly influenced by market demand, government policies, technological advancements, and environmental and safety concerns. Besides, it was highly regulated and was subject to significant geopolitical risks.

4.5. OpEx Methodologies Approaches (RQ3)

The deployment approach and how companies organise their OpEx teams are crucial elements for implementing OpEx initiatives. Based on the interviews, there were five types of OpEx deployment approaches in the energy sector in Oman, as shown in Table 4. These types included: selective teams, systematic cross-functional teams, top-down strategic goals, bottom-up individual activities and a mixed approach (Cesarotti and Spada, 2009).

The sponsor in the organisation selected the approach based on their business case and needs. For instance, the selective team deployment was a common option for the PPS methodology, and five interviewees cited this approach, justifying that 'the selection for these teams is based on the deployment that has the most impact on the business and within the organisation resource capacity' (cases 4, 5, 7, 12 and 17). "*Our deployment started where the most business impact happen, and you know one of the important business units for us is the operation and the technical"* [2; CEO].

In the systematic or cross-functional approach, the organisation followed a structured OpEx deployment with a transformation map and a known framework for selected methodologies like Lean or Six Sigma. This approach targeted and covered all business units and functions in the organisation (1, 8, 9 and 11). The top-down approach, like Kaizen, was used to drive and execute some strategic goals for interviewees 4 and 5 such as a quick and structured operation of the business. "*In our group, we have selected a top-down approach in deploying OpEx and we used the Kaizen methodology to operate that"* [5, GM].

A mixed approach was cited by interviewees 1 and 14, involving the use of Lean and Six Sigma for bottom-up activities while linking them to goal deployment (Hoshin-Kanri) from the top to align the business and achieve maximum value (Tennant and Roberts, 2001). Interviewee 10 mentioned a bottom-up approach to deploy OpEx and improve some units of the business with basic OpEx methodologies. The deployment approach theme was observed and reported during the systematic literature review (Al Zaabi et al., 2022) in some publications under the title 'framework or model'. The main focus was on the integration aspects of the deployment approach (de Mattos Nascimento et al., 2019) and the success factors of the OpEx approach (Yazdi et al., 2021). It was noted that these

frameworks addressed only specific methodologies or case studies, and none of the publications investigated a full OpEx methodology approach. The significant aspect of the interview was that it addressed and provided valuable information about the different practical approaches, especially the full cross-functional systematic approach as per Table 4. Additionally, it covered most ranges of the energy sector with a wider range of methodologies.

Table 4: Description of deployment approaches

Deployment Type	Description	Interviewee
Selective Team	Approach a small process in a selected department within the organisation and apply OpEx	4, 5, 7, 12 and 17
Systematic Cross Functions	Approach the whole organisation with OpEx transformation to every corner of the business, both top-down and bottom-up	1, 8,9 and 11
Top-Down Goals	Start the deployment from the top with the organisation's strategic goals and use OpEx to drive them	4 and 5
Mixed Approach	Combination of top-down and bottom-up for different departments in the organisation	2 and 14
Bottom-Up	Start the deployment from the bottom with the business activities and use OpEx methodologies to execute them	10

4.6. Sustainability Factors for OpEx Methodologies (RQ4)

This section discusses the sustainability factor during and post-OpEx implementation in the energy company (Erdil et al., 2018). In this work, 13 out of 18 interviewees stated that rewards were the main sustainability factor for people to be part of the OpEx deployment and to continue it further. "*I do the rewarding by myself to encourage my people and every*

month I announce the employee of the month, and if anybody completes an OpEx project he will be rewarded 500$ for his efforts [6, GM]. *We do have a reward and recognition scheme in place to recognise the good idea and OpEx projects, however, I see a gap in that system, and we need to do more if it"* [2, CEO].

The second major factor for OpEx sustainability was the alignment of OpEx activities with the organisation's priority, cited by interviewees 1, 5, 10, 11, 13, 14, 15 and 18. "*My philosophy is to ensure everyone delivers to a similar objective so when you roll up all the divisions you end up with high cumulative and anything not structurally aligned will be reported* [1, CEO]. *We have introduced an enterprise alignment team to enable the organisation to work toward the same goal and achieve the same objectives"* [18, CFO].

Based on interviewees 2, 3, 8, 9 12, 14 and 15, it was noted that a highly positive organisational culture supported the implementation of OpEx and sustained it thanks to its high value and return of investment. "*To drive that culture change you have to do it slowly through evolution, where you have to do a small change and sustain the direction and you expand more and more"* [3, CEO].

The leader's commitment to engage and support through the Leader Standard Work (LSW) was referenced 11 times by five interviewees as one of the key elements for the sustainability of OpEx post-implementation. LSW provided a foundation for continuity in OpEx management in one unit. Each time a new team leader or supervisor started to work in an OpEx area, things should continue to operate in the same way, assuming the process was stable (Mann, 2005). "*The top management commitment is critical and essential to sustain* [2, CEO]. *The CEO talked about OpEx methodologies, like Agile, and why we needed to continue staying adaptable to the change"* [8, OpEx lead].

Interviewees 1, 2, 3 and 7 mentioned that sustainability strategy was important for OpEx implementation and should be designed upfront for the organisation. "*The sustainability, scale and replication remain very painful, and you must have a sustainability strategy to sustain the programme"* [3, CEO].

Interviewees 5 and 6 stated that OpEx should be monitored through a performance management system to sustain and move in the right direction. One case cited the

importance of a guiding principle for any programme implementation, "*as long as those guiding principles were black and white and it is clear where we are going and what it means to what, and what success looks like, then everyone believes and change sustains"* [3, CEO].

Interviewee 11 provided that the selection of the right method for the project enabled the programme to sustain. Interestingly, the author observed that most of the drivers for the energy sector in Oman were different from those in the literature. This additional data provides valuable insights for the research but might be specific to the energy sector in Oman only. Thus, the overall ranking for the sustainability of implementing OpEx is as follows:

- Rewards and recognition (cited by 1, 10, 11, 12, 14, 17, 18, 2, 4, 6, 7, 8 and 9).
- Alignment with the company's strategic priority and goals (cited by 1, 5, 10, 11, 13, 14, 15 and 18).
- Culture aimed at sustainability and improvement (cited by 2, 3, 8, 9 12, 14 and 15).
- Leadership commitment (LSW) (cited by 12, 2, 7, 8 and 9).
- Sustainability strategy (cited by 1, 2, 3 and 7).
- Audit and monitoring (cited by 5 and 6).
- Guiding principle (cited by 3).
- Selection of the OpEx methodology (cited by 11).

4.7. New Identified Themes

4.7.1 OpEx Management System

Almost all the interviewees cited the OpEx or CI management system, which is a set of policies, processes and procedures used by their organisations to ensure the tasks required to achieve its objectives are accomplished (Charron et al., 2014). The OpEx or CI system is similar to the international standard ISO 9000 for quality management systems, which can be defined as a '*set of interrelated or interacting elements of an organisation to establish objectives and processes and to achieve those objectives'* (Pfeifer et al., 2004). The author observed that each company had its own system that suited the business, and

there was no consistency between them. However, all interviewees believed in the importance of the system to support and sustain OpEx implementation in their organisation. The components of the OpEx system are described in Table 5 and presented in Figure 6.

The most cited component was the KPI, which was mentioned by seven interviewees. "*We have our KPI setting together e.g., production and cost, linked to the LSW of the people in one system called CI fundamental"* [15, OpEx practitioner]. Interviewees 2, 6 and 7 cited the importance of having a safe environment and system for people to think and generate ideas. Then, these ideas would be tracked and recorded on an electronic and hard card. "*We have a dashboard where everybody contributes, it is automated and simple to use. We are using it effectively to identify improvement ideas and work them out by the teams"* [2, CEO]. Interviewees 7, 8 and 9 mentioned that they used to huddle frequently to review the target and discuss how to improve the performance through the OpEx management system.

Another important component of the system was the visual management. "*We are monitoring the performance by having clear visual management for different levels depending on the goal level with support from the leadership integrated with different teams for different events"* [12, OpEx expert]. In LSW, leaders spent 20% of their time supporting staff with this critical process (interviewees 3 and 15).

The last component of the OpEx system was the Standard Operating Procedure (SOP), which was cited by interviewee 6 as being important to sustain the new improvement or methodology.

In summary, there is a lack of consistency between different company systems which impacted the effectiveness of OpEx implementation in this sector and there were no strategies to address this issue.

Table 5: OpEx system components cited by interviewees.

System Component	Description	Cases
Key Performance Indicator, KPI	An indicator of progress towards a target t	2, 3, 4, 7, 11, 14 and 15
CI/OpEx Idea Cards	Card to write up ideas either individually or collectively	2, 6 and 7
Dashboard	Displays KPI in interactive charts and graphs, allowing for quick and organised review and analysis	2, 3 and 10
Huddle	A meeting hold every day in the business	7, 8 and 9
Visual Management, VM	A form of communication used to give a snapshot of operations	8, 11 and 12
Leader Standard Work, LSW	A daily or weekly routine for the leaders	3 and 15
Standard Operating Procedure, SOP	An instructions to help staff in carry out their operations	6

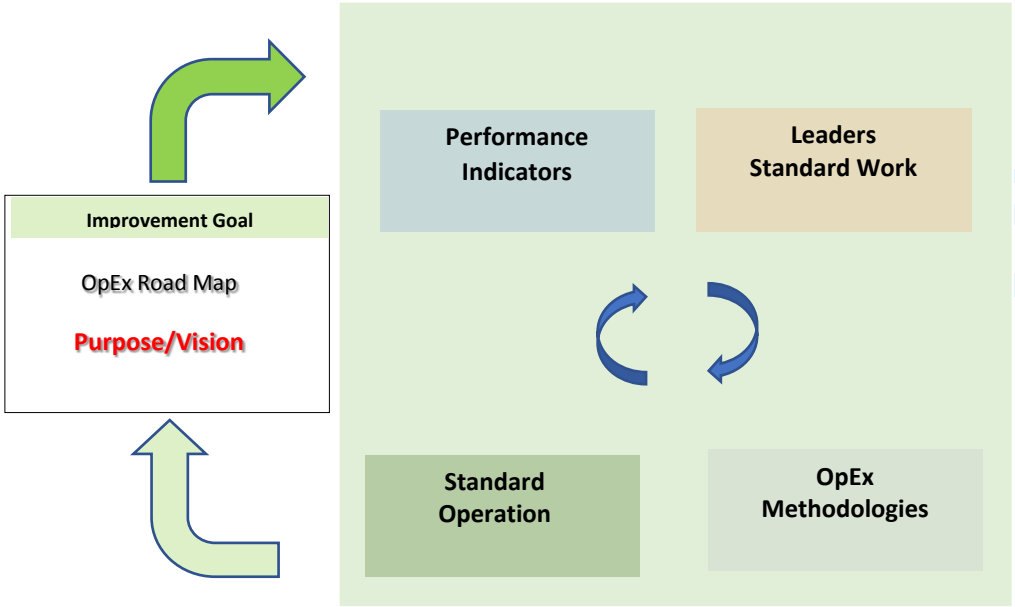

Figure 6: Practical OpEx management system extracted from the interviews.

4.7.2. OpEx Enablers and Influencers

The successful implementation of OpEx in some companies in the energy sector was influenced by several factors, as cited by many interviewees. Notably, a theme not found in the existing literature was the significance of specific enablers that contributed to the success of OpEx initiatives. The most frequently mentioned enabler was having a road map for the OpEx implementation, which was emphasised by 10 interviewees, as shown in Table 6; *"we started with a road map which has a sort of milestone to achieve"* [4, GM]. "*We don't have a roadmap, but we are heading for three years transformation plan with aspirational targets"* [7, Deployment lead].

Additionally, seven participants highlighted the importance of having a proper structure and set-up to enable effective OpEx implementation. "*I would highly recommend any organization that wants to introduce OpEx or CI in their own organisation to have it as a standalone and not to combine it with any other function"* [17, HR manager].

Interviewees 8 and 18 underscored the significance of finance to enable the implementation of OpEx in the organisation. "*The finance partner is very important for OpEx as it does the validation in a regular way and enables the deployment"* [18, CFO].

Interviewees 5 and 10 cited the importance of integrating processes and technology to sustain and maximise the value of improvements. "*Digitalisation immediately after engineering the process enables sustainability and reduces resistance to change"* [10, OpEx Lead].

Furthermore, the OpEx system or team-based approach was addressed in section 4.2.3 and cited by interviewee 11 as a key enabler for successful implementation and sustainability. Interviewee 9 highlighted that their organisation faced challenges in running any OpEx initiatives due to the lack of a required system. Additionally, having enough quality people was deemed crucial for enabling the implementation. Interviewee 17 was assigned as a full-time human resource to recruit experts and people for the organisation to enable the implementation. "*My role is mainly around resourcing and developing talent to enable and sustain the implantation"* [17, HR manager]. Interview 11 mentioned the impact of having

a project funnel: "*Through a project funnel, we know the required resources and we can do project prioritisation and the selection for the best tools to solve the problems"*.

Table 6: List of factors enabling successful OpEx implementation at a company

Implementation Enablers	Description and Summary of Citations	Interview
Road Map	A plan outlines goals, strategies, and major milestones that an organisation or individual intends to achieve within a certain time	1, 2, 11, 3, 4, 7, 9, 10, 14 and 16
In House Capability	Having a standalone capability in the organisation to do the OpEx	1, 6, 8, 9, 11, 14 and 17
Finance	Managing budgets for OpEx and analysing financial value for each project and making recommendations on the implementation	8 and 18
Digitalisation	Digitalising the operation process after improvement, enabling it to maximise the value and sustain	5 and 10
Fundamental System	A platform helps to implement OpEx systematically at the company	9 and 11
Resourcing	Having enough on-time quality resources that enable successful implementation of OpEx	17
Project Funnel	Having pre-defined funnels for all the opportunities for OpEx helps to maximise the value.	11

4.7.3. OpEx Influencers

An influencer, in this context, is someone or an entity in the energy industry who possesses OpEx knowledge, authority, or insight into the deployment of the OpEx journey. Several interviewees have cited influencers who played a significant role in initiating their or their company's OpEx journey.

The first influencer mentioned was the CEO (Interviewees 4, 8, 9 and 13): "*The CEO himself talked about OpEx and agility and the need to stay adaptable, and he continuously speaks about this and provides all the support for this programme"* [8, OpEx Lead].

The second influencer was of Global influence (1, 8, 13 and 14). They apply standardised processes globally, with a structured and straightforward approach [1, CEO]. This global influence was observed in international or global companies like BP and Shell, which operate businesses worldwide.

The third influencer was the Government (5, 6 and 9): *"His Excellency mentioned the national company has implemented OpEx and why you don't take a lead on that"* [9, OpEx lead].

The fourth influencer was the National Company (4 and 7): "*we got influenced by the National Company in regard to the operational excellence for our business and what kind of things we need to have from the road map into our plans"* [7, OpEx lead].

The fifth influencer was the OpEx Expert (4 and 17): *"our id was driven by an experienced guy who came from the OpEx working environment"* [4, GM]. The last was the shareholder (5*): "The shareholder requirements for our manager to use OpEx as one way of being cost competitive"* [5, GM].

5. Discussion on the New Findings and Benchmarks

From the 18 interviews, the author identified 10 main themes and 73 sub-themes. Among these themes, six were consistent with the ones found in the literature (Al Zaabi et al., 2022): methodology, approach, benefits, motivation, challenges and sustainability. Additionally, further analysis has revealed four novel findings: system, resources, influencers and enablers.

The key OpEx methodologies (RQ1) cited during the interview included Lean methodology as the dominant, Six Sigma as second popular. Then, Lean Six Sigma, Kaizen and agile. All these methodologies were observed and aligned with the prior studies and literature (Al Zaabi et al., 2022). A few new methodologies for OpEx in the energy sector in Oman were mentioned by the interviewees and were not part of the prior studies and

literature. These methodologies include Practical Problem Solving (PPS) (Al Hinai et al., 2022), Assets Management System (AMS), Goal Deployment, Operation Integrity and Gap Analysis (Bryant et al., 2021, Al Ghafri et al., 2022).

Interestingly, the author noticed that most of the motivation (RQ2) for the energy sector in Oman differed from those identified in the literature (Perey et al., 2018). This data provided valuable additional insights for further research. However, it is possible that these differences are unique to the energy sector in Oman, which can be attributed to its highly dynamic and constantly evolving nature.

The qualitative analysis for the OpEx methodologies implementation cited five types of OpEx deployment approaches (RQ3) in the energy sector in Oman. These types included selective teams, systematic cross-all functions, top-down strategic goals, bottom-up individual activities, and mixed approaches. None of these approaches was observed or reported during the SLR (Al Zaabi et al., 2022) which was focusing only on the integration aspects of the deployment approach (de Mattos Nascimento et al., 2019) and the Success Factors of the OpEx approach (Yazdi et al., 2021).

The key findings from the interview on the sustainability factor (RQ4); 13 out of 18 interviewees stated that reward was the main sustainability factor for people to be part of the OpEx deployment. Followed by the alignment of OpEx activities with the organisation's priority. Third, a highly positive organisational culture and the leader's commitment to engage and support through the LSW. The author observed that most of the drivers for the energy sector in Oman differed from those in the literature (Laureani and Antony, 2012) , and this was additional data for the research but might be common for the energy sector in Oman only.

This study revealed significant novel insights concerning the personnel and human resource frameworks crucial for the efficient integration of OpEx methodologies within an organization which absent within the prevailing literature. Furthermore, it illuminated the OpEx management system, encompassing a set of policies, processes, and procedures employed by the organization to ensure the proficient execution of tasks essential for goal attainment. Importantly, these revelations had not been previously documented in the current body of literature.

6. Implications, Prerequisites and Limitations

6.1. Implications to Theory and Practice

This paper addresses some important gaps in the literature, such as understanding the application of a range of OpEx methodologies for the energy sector, including their adoption, motivation factors, approaches and requirements to sustain OpEx. The study contribution to the theory by:

(1) Highlighted the discovery Practical Problem Solving (PPS) as the primary OpEx methodology within the energy sector illuminates its significance in shaping the operational landscape of the energy sector, setting a precedent for future methodologies and operational frameworks within the industry.

(2) The adoption of the common OpEx methodologies within Oman's energy sector reflects a convergence with global trends observed in both energy and non-energy industries across diverse countries.

(3) Notably, the consistent in implementing OpEx methodologies such as Lean, Six Sigma, Lean Six Sigma, Kaizen, and Agile underscores a strategic alignment with practices witnessed in various international contexts which validates the versatility and adaptability of these methodologies and signifies their universal applicability in addressing operational challenges.

The study contribution to the practice by:

(1) Points to an increase in the business needs for the application of OpEx in Oman, especially in the oil and gas industry.

(2) Provides a practical framework and guidelines for implementing and sustaining OpEx in the energy sector of a country.

(3) The information gathered from the literature review and the interviews can serve as a helpful tool to assess the current state of OpEx for any company and guide interested individuals in selecting the appropriate methodology and maturity levels. This will aid in understanding the potential of OpEx and achieving higher levels of business performance.

(4) Provides information that can also support leadership in making comparisons among energy organisations, benchmarking, or adapting an approach and

framework on how to successfully deploy OpEx methodologies in their organisation. This will help them achieve their goals of improved quality, higher safety, increased productivity and reduced costs.

OpEx methodologies promote a culture of continuous improvement and business excellence, encouraging employees to identify and solve problems. This approach leads to various benefits, including improved quality, increased staff satisfaction and higher profitability. Moreover, OpEx fosters a holistic view of quality and safety in the energy sector, considering them integral parts of the entire organisation rather than isolated to specific departments or individuals. In addition to these advantages, OpEx methodologies significantly contribute to cost reduction by enhancing efficiency and eliminating waste. This is achieved through the elimination of unnecessary steps, streamlining processes and leveraging technology to increase productivity.

6.2. Prerequisites for OpEx Deployment

Before deploying OpEx methodological framework, it is important to ensure certain prerequisites are in place to maximize its effectiveness. These are sponsorship and commitment from top management, clear strategic objectives, assess the existing organizational culture and ensure that it supports the principles of OpEx, employee engagement nd training, data availability and quality, a clear understanding of existing, define key performance indicators (KPIs) and metrics to measure the effectiveness of OpEx initiatives, and implement effective change management processes to manage resistance to change and ensure successful implementation. By addressing these prerequisites, organizations can increase the likelihood of success when deploying an Operational Excellence methodological framework.

6.3. Limitations and Scope for Future Research

We acknowledge that this study has certain limitations, given its qualitative and exploratory nature. To enhance the generalisability of our findings, it would be valuable to extend this framework to other research settings where OpEx is relevant and highly encouraged. A key gap identified by most interviewees and supported by the literature was the lack of a framework and roadmap for implementing OpEx methodologies in the energy

sector. This research was limited to Oman and the findings and conclusions drawn from Omani energy companies may have limited applicability to energy companies in other regions. The following also are the key limitations of our work:

(1) limited number of interviews, to increase the validity of the data, further validation using other methods such as surveys and input from more subject experts (Delphi) is required.

(2) Due to the nature of the interviewees being primarily CEOs and leaders, in-depth information concerning OpEx tools and details was limited, as most interviews focused on strategic and practical points. Conducting a survey with practitioners and OpEx experts would yield additional valuable insights.

(3) Additionally, future research could explore the reasons behind the lower level of OpEx application in some organisations, which might be attributed to financial constraints or the small size of businesses in the energy sector in Oman.

7. Conclusions

This work presents a qualitative analysis of OpEx methodologies, which are considered key solutions for addressing the significant challenges faced by the energy sector during operations. The study has achieved the objectives by; assessing successfully the current state of OpEx methodologies by conducting semi-structured interviews with 18 participants from the energy sector who are knowledgeable about OpEx in energy industry and provided answers to the main four research questions.

The analysis of OpEx revealed a growing demand and relevance for its application in the energy sector in Oman, particularly within the oil and gas industry. From the 18 interviews conducted, the author identified 10 key themes and 73 sub-themes. Among these themes, six were consistent with the ones in the literature (Al Zaabi et al., 2022): methodology, approach, benefits, motivation, challenges, and sustainability. Additionally, the analysis revealed four novel findings: system, resources, influencers, and enablers. This work has provided valuable information about the practical methodologies, approaches, and systems that could be used for a practical OpEx implementation and scope for further work.

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