FUZZY-BASED EVALUATION OF INTELLECTUAL PROPERTY VALUE FOR THE ENERGY SECTOR

Dr. Manal Saad Alghamdi

IP Specialist, Saudi Aramco

Dr. Christopher M. Durugbo

Associate Professor of Supply Chain and Service Innovation

Introduction

- To satisfy the rising energy demands, traditional methods of supplying energy are unsustainable especially considering climate change challenges
- Higher levels of technological and non-technological innovations are necessary for the supply side of the energy equation, which includes cleaner energy sources
- Intellectual property (IP) is the cornerstone of these innovations and initiatives that are essential to technology life cycles and serve as catalysts for technical advancement in energy sector
- However, for energy companies to develop valuable IP portfolios, there needs to be an awareness of how IP value appropriated – a process that begins by defining and evaluating IP value
- The aim of this study is to evaluate the critical form of IP value and the core management strategy (work in progress) that delivers enhanced IP value for the energy sector
- The presented study analyse the perspective of IP specialists working in energy industry on dimensions and forms of IP value using the Fuzzy Analytical Hierarchical Process (Fuzzy-AHP)

Overview

Forecasts by the International Energy Agency (IEA) suggest the world's energy consumption could increase by up to 30% by 2040 (IEA, 2019).

According to world Intellectual Property Organization (WIPO), higher levels of innovation are necessary for the supply side of the energy equation, which includes cleaner energy sources, smart cities, energy-efficient industries, transportation, as well as enabling technologies for the optimization of energy systems, such as smart grids and new advanced energy storage technologies (Leon, Bergquist, Vincent, & Fushimi, 2019)

Hence, the European Patent Office (EPO) and the IAE (2023) report states that, average annual growth rate of patent applications for hydrogen generating systems, for example, increased by 18% since 2005 (Ungria, Rodriguez, & Burattini, 2023).

Overview

The future of the economy rests more than ever on the human potential for invention and creativity **to be able to address challenges across the energy**, **geopolitics, and environmental sectors** (Ungria et al., 2023)

Technology development in the renewable energy sector **demands a significant upfront investment** from businesses and takes a lot of time (Kim et al., 2018), thus, focus should be on increasing the value of intellectual property for energy sector

The investment in the invention's development is repaid through owning exclusive rights to inventions, which also produce bigger profits (Hartwell & Marco, 2016) and therefore **appropriates value from intellectual property**

Methodology

- **Sampling:**

The study adopts a purposive approach, specifically **IP experts working in the energy sector** in Kingdom of Saudi Arabia.

Saudi Arabia continues to introduce IP-related policies aimed at transitioning to a more knowledge-based economy. For instance, the Kingdom established the Saudi Authority for Intellectual Property (SAIP), in 2017 and developed a National Strategy for IP that targets enhanced industrial and technological competitiveness of the Kingdom.

- **Data collection:**

We previously developed a **preliminary model comprising dimensions of IP value** and based on that we prepared a **questionnaire** containing IP value forms for evaluation

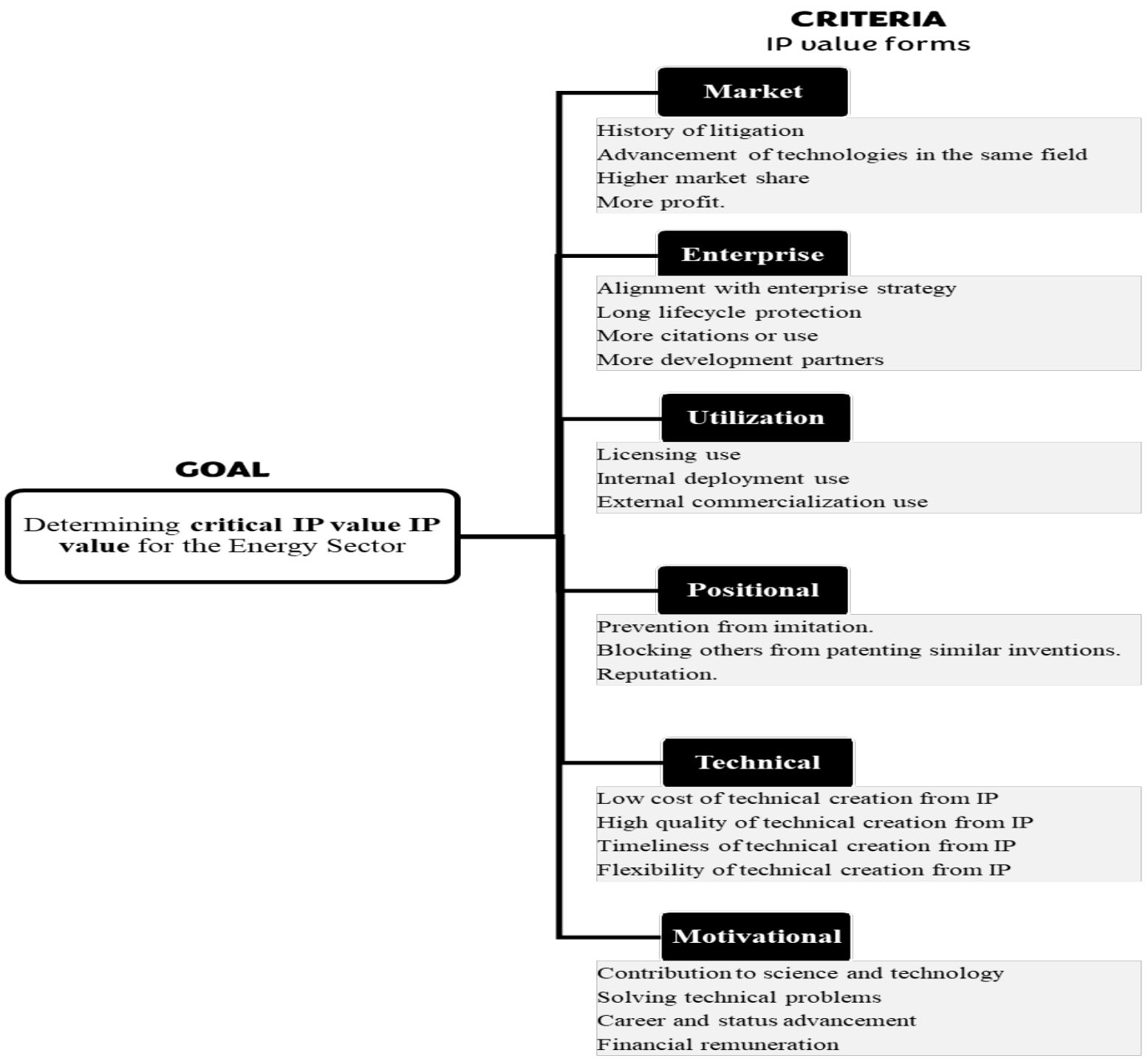
- **Data analysis:**

The study involves the widely used **Analytic Hierarchy Process (AHP)** (Saaty, 1980) to address our research question, i.e.,

What is the critical form of IP value for the energy sector, from the perspective of IP managers, scientists and specialists?

Methodology

The research question reflects our decision problem and *Figure* shows the **hierarchical structure of our goal, dimensions, and criteria of IP value.** Using the triangular fuzzy numbers that are defined as a triplet (a1, a2, a3) where “a1” represents smallest likely value, we define decision matrices for the AHP-based evaluation of IP value and derive fuzzy-based pairwise comparison matrices using the relative rankings of experts. The **IP value criteria** used for the evaluation is based on a previously conducted systematic literature review (AlGhamdi & Durugbo, 2022), as summarised in Table 1.



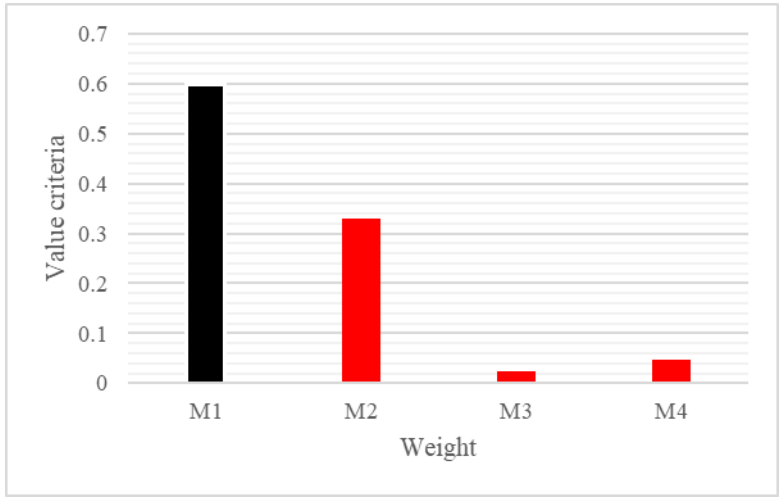
IP value dimension	Overview	Value criteria	References
Market	**Pertains to the market conditions, demand, and prospects of IP for energy firms**	History of litigation	Ma et al. (2019); Grimaldi & Cricelli (2020)
		Advancement of technologies in the same field	
		Higher market share	
		More profit.	
Enterprise	**Concerns collaboration, co-creation and co-ownership of IP with partners of energy firms**	Alignment with enterprise strategy	
		Long lifecycle protection	
		More citations or use	
		More development partners	
Utilization	**Considers Using IP for wealth generation and economic growth by energy firms**	Licensing use	Malewicki & Sivakumar (2004); Gambardella et al. (2005)
		Internal deployment use	
		External commercialization use	
Positional	**Relates to Strategic positioning derived from IP for energy firms**	Prevention from imitation.	Gambardella et al. (2005)
		Blocking others from patenting similar inventions.	
		Reputation.	
Technical	**Involves Operational benefits of technical solutions from IP for energy firms**	Low cost of technical creation from IP	Boyer & Lewis (2002); Ma et al. (2019)
		High quality of technical creation from IP	
		Timeline of technical creation from IP	
		Flexibility of technical creation from IP	
Motivational	**Includes Invention motives for IP for individuals or firms in the energy sector**	Contribution to science and technology	Malewicki & Sivakumar (2004); Gambardella et al. (2005)
		Solving technical problems	
		Career and status advancement	
		Financial compensation	

Results

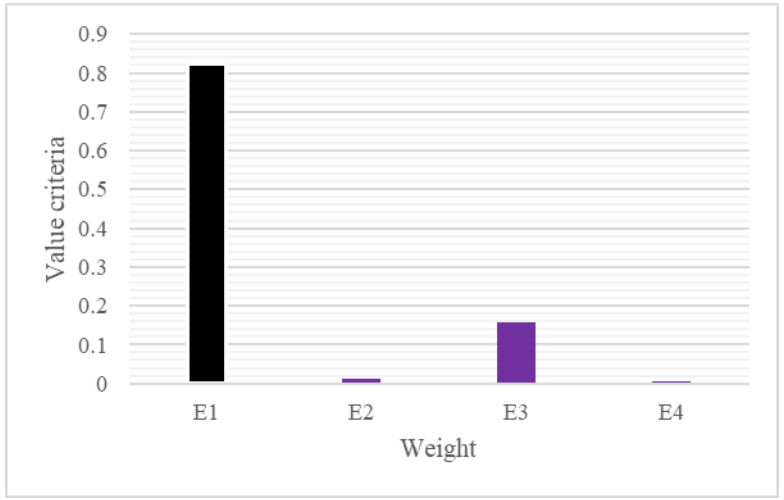
Table 3 presents the main findings on AHP weights and rankings for IP value criteria. The table shows that the motivational dimension includes the highest (first overall) criteria, ‘solving technical problems’ (**Mo2**), as well as lowest (last overall) criteria, ‘career and status advancement’ (**Mo3**).

IP value	Value criteria	Code	Weight	Rank
Market dimension	History of litigation (monetary compensation from potential infringers)	M1	0.5981	5
	Advancement of technologies in the same field	M2	0.3302	8
	Higher market share	M3	0.0236	19
	More profit.	M4	0.0481	15
Enterprise dimension	Alignment with enterprise strategy	E1	0.8244	2
	Long lifecycle protection	E2	0.0111	20
	More citations or use	E3	0.1584	9
	More development partners	E4	0.0061	21
Utilization dimension	Licensing use (sell idea)	U1	0.7923	4
	Internal deployment use	U2	0.0862	12
	External commercialization use (sell final product)	U3	0.1216	10
Positional dimension	Prevention from imitation after production	P1	0.0378	17
	Blocking others from patenting similar ideas	P2	0.5524	6
	Reputation.	P3	0.4097	7
Technical dimension	Low cost of technical creation from IP	T1	0.0971	11
	High quality of technical creation from IP	T2	0.8057	3
	Timeliness of technical creation from IP	T3	0.0506	14
	Flexibility of technical creation from IP	T4	0.0465	16
Motivational dimension	Contribution to science and technology	Mo1	0.0787	13
	Solving technical problems	Mo2	0.8871	1
	Career and status advancement	Mo3	0.0049	22
	Financial compensation	Mo4	0.0292	18

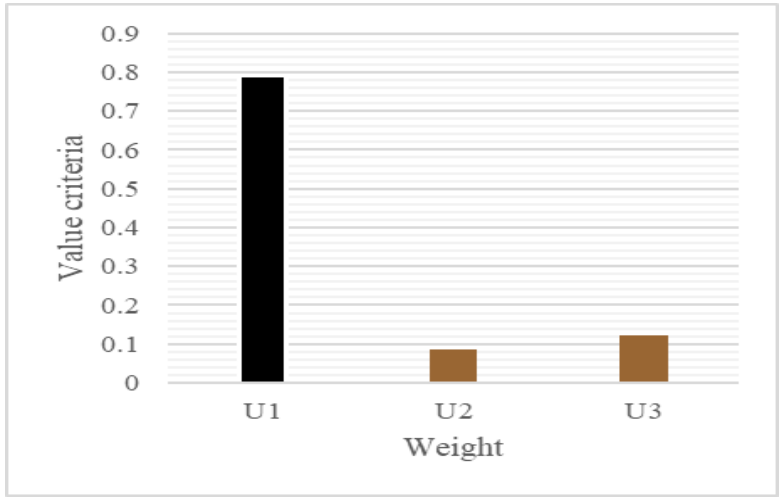
A breakdown of findings based on the different IPV dimensions



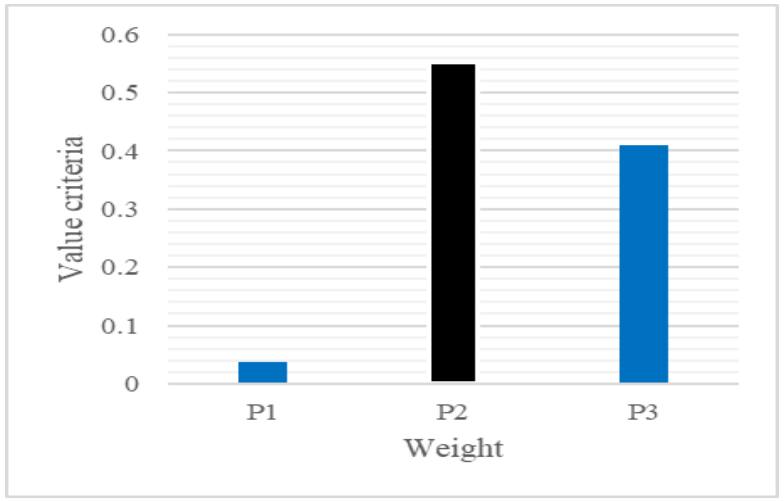
Weights of IPV criteria for market dimension



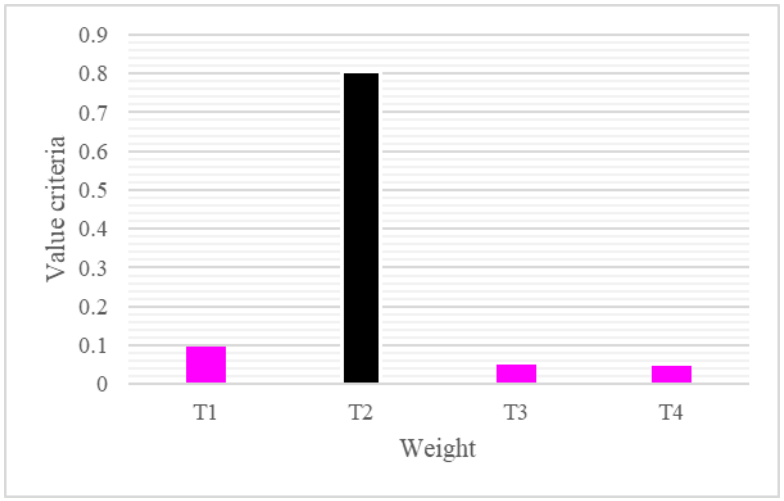
Weights of IPV criteria for enterprise dimension



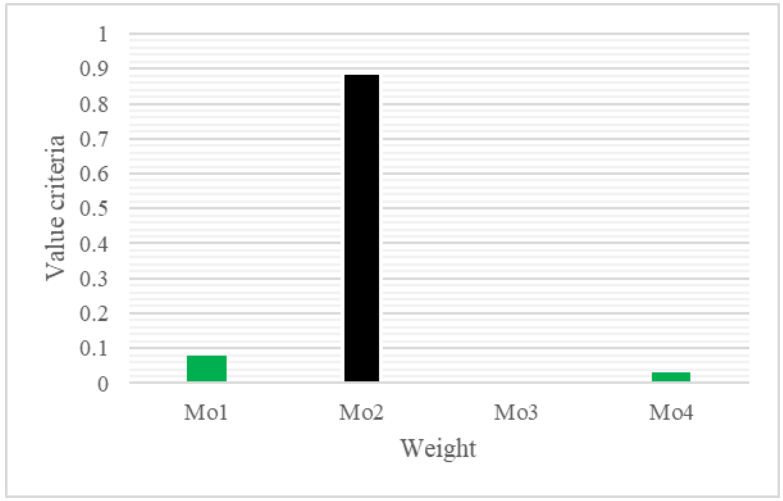
Weights of IPV criteria for utilization dimension



Weights of IPV criteria for positional dimension



Weights of IPV criteria for technical dimension



Weights of IPV criteria for motivational dimension

Conclusions & Limitations

Conclusions

- IP is a crucial economic tool for the successful commercialization and return on investment driving energy sector towards the creation of new technologies.
- However, the energy sector is a cross-technological industry with a constrained market coverage and extremely mature patent portfolios
- For the accrual of IP portfolio value, it seems the **defining and solving of technical problems** will spur scientists and engineers; while **alignment with enterprise strategy** will prompt energy firms

Recommendations

Therefore, we recommend that corporate strategies for energy firms reflect these imperatives for motivational and enterprise value in energy transition initiatives and incentives

Thank you..