Application of an Integrated Risk Framework for the UK In-Stream Tidal Energy Industry

By George Read and Athanasios Kolios

UK In-Stream Tidal Energy Industry

- Clean and predictable source of energy
- Immature Industry and is not yet commercially viable
- Potential to be worth £6.1 billion to the UK
- The UK has 50% of Europe's tidal energy resources
- Many different risks must be overcome in order for the industry to succeed

PESTLE Analysis of the UK Tidal Energy Industry

Cranfield UNIVERSITY

- PESTLE – Political, Economic, Technological, Social, Legal and Environmental.
- Comprehensive form of analysis to highlight all aspects of risk not just focusing on technological and economic risks
- Common business technique used to highlight both opportunities and threats but used in this study to identify risks and key stakeholders

Risks by Category

POLITICAL
- European level politics
- Environmental related politics
- UN not supporting future renewable energy developments
- Politicians may focus on proven renewable energy sources
- National level politics – insecurity of part in power
- Government cut backs in spending for renewables
- Difference in regional political support within the UK

ECONOMIC
- Securing (private) capital investment
- Financing through banking system
- High cost of technology at current
- True cost of tidal developments (CAPEX & OPEX)
- Unit and array deployment
- Current projection for investment pay off
- Global recession and uncertainty of future economy
- Public sector investment/involvement including R&D funding
- Cost of electricity from tidal energy
- Government incentives (subsidies)
- Competing renewable technologies
- Competing conventional technologies
- Insurer risk
- Cost effective technology

SOCIAL
- Social groups being ignored/not being involved
- Social groups delaying/stopping a project
- Local scale opposition
- National level opposition
- Public acceptance
- Public support
- Awareness of technology
- Fishing communities – incentive schemes
- Commercial and recreational boating
- Emergency services
- Tourism
- Resistance of existing technology

TECHNOLOGICAL
- Maturity of technology
- Understanding the engineering of the technology
- Engineering design uncertainty
- Engineering design of components
- Supply chain
- Reliability (component & system)
- Effective power output
- Fragmented industry (no widely accepted configuration)
- Support methods
- Anchoring & mooring
- Design variability based on depth and conditions
- Restriction in prototyping and lack of numerical tools
- System efficiency on array scale development
- Availability of design standards and certification guidelines
- Installation & commissioning
- Grid connection
- Maintenance
- Removal and decommissioning
- Transferability of knowledge from similar industries

LEGAL
- Changes in legislation
- Complicated legislation
- Commitment to legally bound renewable targets
- Strategic Environmental Assessments
- Environmental Impact Assessments
- Difference in legislation between different countries
- Overlooking details of legislation
- Planning permission
- Licensing
- Intellectual property
- Costs associated with legal battles

ENVIRONMENTAL
- Carbon footprint and lifecycle assessment
- Short term Environmental damage
- Long term environmental damage
- Unknown environmental impacts
- Environmentalists causing delays
- Indirect environmental damage
- Collision risk

Key Stakeholders

Cranfield UNIVERSITY

POLITICAL	ECONOMIC	SOCIAL
ACER	Competing conventional energy	RNLI
Department of Energy Northern Ireland	CORDIS	Commercial Shipping
EU-Ocean Energy Association	DOENI	Dredging Communities
European Commission	Energy Technologies Inst.	Emergency Services
International Energy Agency	European Commission	Fishing Communities
IRENA	Green Investment Bank	Local Communities
Local Councils	Insurers	National Support
RenewableUK	Market Competition	Royal Yaught Association
Scottish Government	Other Public Investors	Tourism
Scottish Ministers (W&T)	Private Banks	Surfers
The Carbon Trust	Private Investors	
The Energy Community	Scottish Ministers	
UK Government - DECC	Technology Strategy Board	
UNESCO	The Carbon Trust	
United Nations - DESA	The Crown Estates	
Welsh Assembly Government	UK Government - DECC	
TECHNOLOGICAL	**LEGAL**	**ENVIRONMENTAL**
CORDIS	DEFRA	CEFAS
Classification e.g. Lloyd's Register & DNV	European Commission	DEFRA
ICEPT/UKERC	Marine licensing Scotland	Environment Agency
Manufacturers	Marine Licensing Wales	Environment and Countryside Dpt.
Marine Installation & Commissioners	Marine Management Org.	EU-OEA
National Grid	National Grid	European Commission
Other Industries e.g. Offshore Wind	Renewable Energy Lawyers	JNCC
RenewableUK	The Crown Estates	Marine Management Org
Suppliers & Supply Chain	UK Government	Natural England
Technology Strategy Board	United Nations (Law of the Sea)	RAFTS
Test Sites e.g. EMEC & Wavehub		RSPB
UK Tidal Developers*		Scottish Heritage
UK Research Organisations e.g. Universities		WWF

Stakeholder Survey

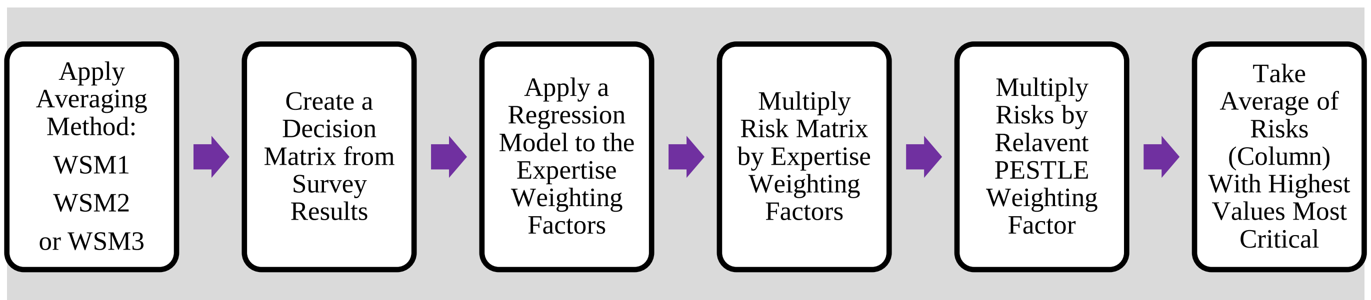
Cranfield UNIVERSITY

- Online survey compiled asking respondents to:
- Categories themselves by relevant PESTLE aspect
- Rank their own academic or industrial expertise
- Assign importance values to PESTLE categories
- Rank the 72 risks on a scale of 1-9

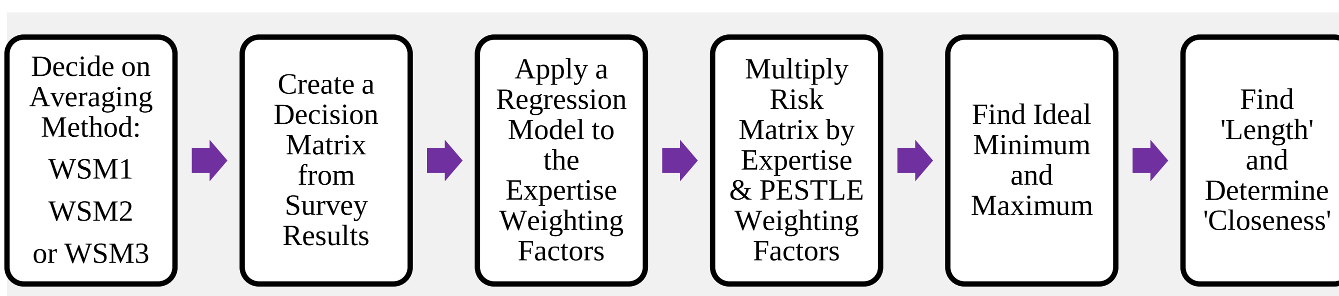
- The different weighting factors allowed results to be manipulated and sensitivity of the results to be assessed
- Three different weighting models were applied to weighting factors; linear, squared and square root

Analysis Methods for Survey Results

- Weighted Sum Method



- TOPSIS



Industrial Results

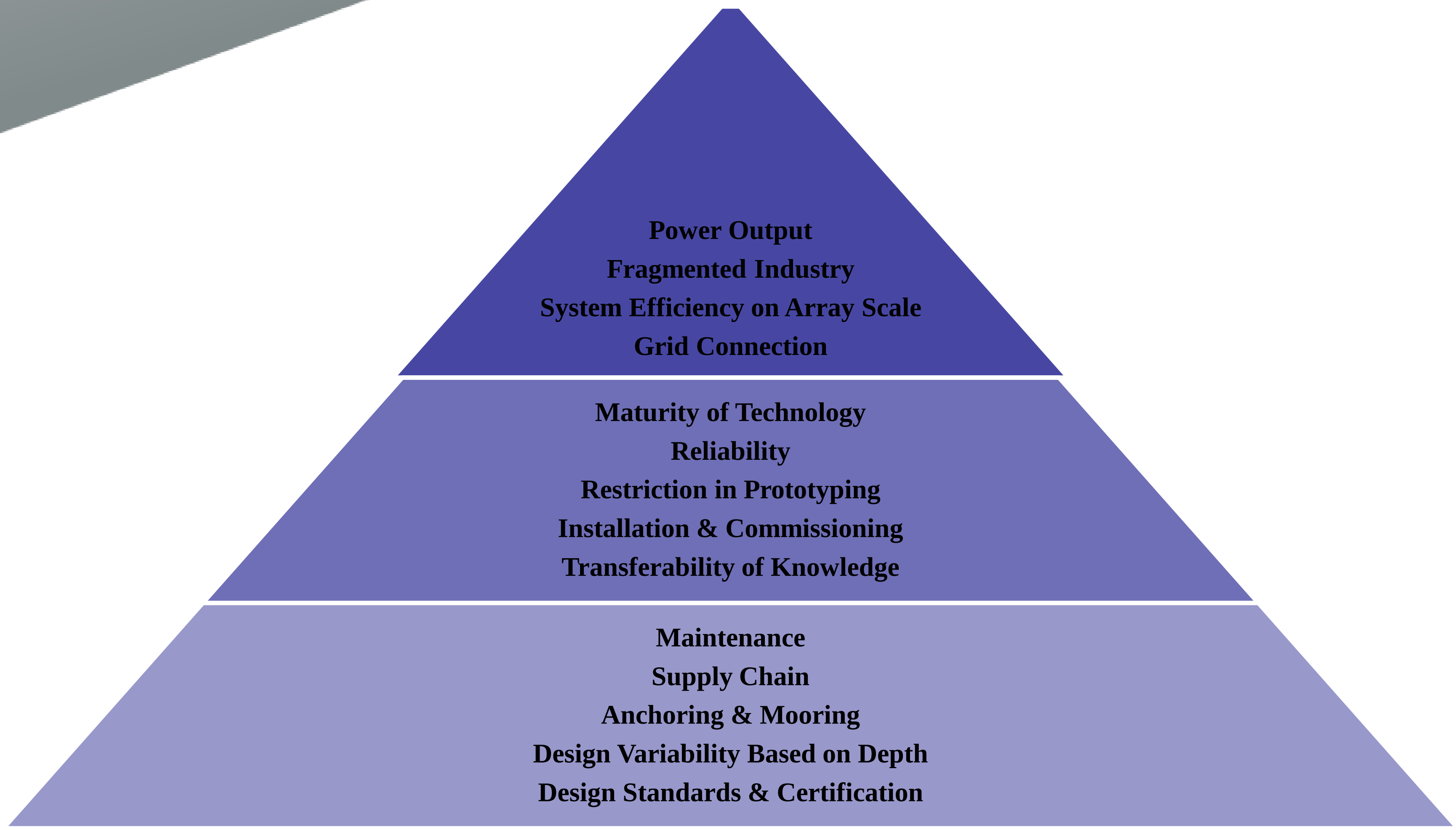
Cranfield UNIVERSITY

METHOD	WEIGHT	RISK 1	RISK 2	RISK 3
TOPSIS1	ALL	Public sector investment	Private Capital	Investment pay off
TOPSIS2	LINEAR	Public sector investment	Investment pay off	Private Capital
TOPSIS2	SQUARED	Investment pay off	Public sector investment	Private Capital
TOPSIS2	SQ. ROOT	Public sector investment	Private Capital	Reliability
TOPSIS3	LINEAR	Competing renewables	Grid connection	Competing conventionals
TOPSIS3	SQUARED	Grid connection	Insurance	Competing renewables
TOPSIS3	SQ. ROOT	Competing renewables	Grid connection	Farm scale impacts
WSM1	ALL	Grid connection	Cost effective tech	Incentives
WSM2	LINEAR	Grid connection	Installation & commission	Maintenance
WSM2	SQUARED	Grid connection	Installation & commission	Maintenance
WSM2	SQ. ROOT	Grid connection	Installation & commission	Maintenance
WSM3	LINEAR	National level politics	Regional support	Other Competing Technology
WSM3	SQUARED	National level politics	Regional support	Other Competing Technology
WSM3	SQ, ROOT	National level politics	Regional support	Other Competing Technology

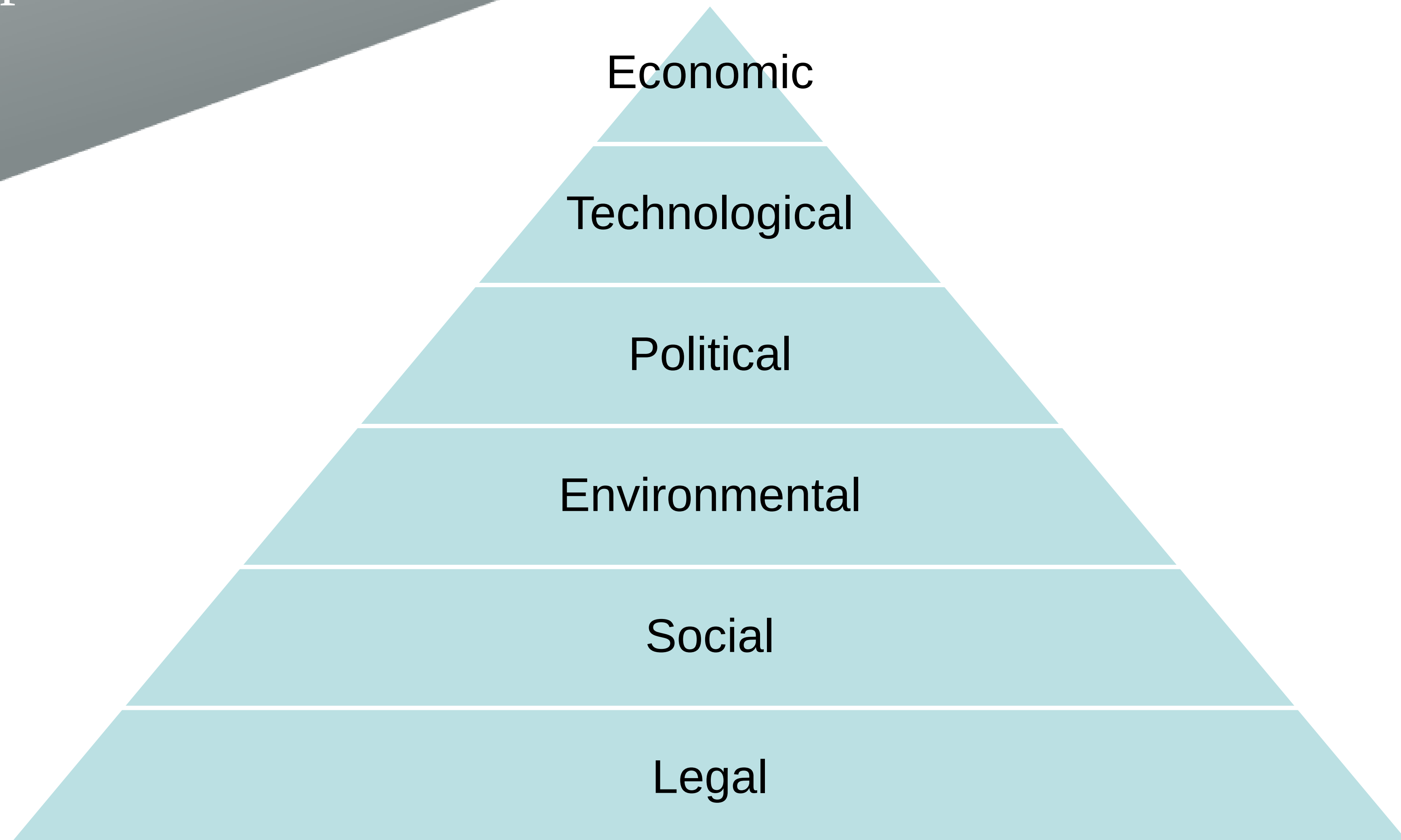
Academic Results

METHOD	WEIGHT	RISK 1	RISK 2	RISK 3
TOPSIS1	ALL	Cut Backs	Maintenance	True cost (CAPEX & OPEX)
TOPSIS2	LINEAR	Maintenance	Installation & commission	True cost (CAPEX & OPEX)
TOPSIS2	SQUARED	Maintenance	Installation & commission	True cost (CAPEX & OPEX)
TOPSIS2	SQ. ROOT	Maintenance	True cost (CAPEX & OPEX)	installation & commission
TOPSIS3	LINEAR	True cost (CAPEX & OPEX)	Maintenance	Unit & Array Scale Development
TOPSIS3	SQUARED	Recession	Cost effective tech	True cost (CAPEX & OPEX)
TOPSIS3	SQ. ROOT	True cost (CAPEX & OPEX)	Grid connection	Competing renewables
WSM1	ALL	Public sector investment	High cost of tech	Private Capital
WSM2	LINEAR	Banking finance	High cost of tech	Public sector investment
WSM2	SQUARED	Banking finance	High cost of tech	Public sector investment
WSM2	SQ. ROOT	Banking finance	High cost of tech	Public sector investment
WSM3	LINEAR	High cost of tech	Cost of electricity produced	Private Capital
WSM3	SQUARED	High cost of tech	Private Capital	Investment pay off
WSM3	SQ. ROOT	High cost of tech	Cost of electricity	Cost effective tech

Insurer Opinion



Critical Risks – Overall Opinion



Future Work

Future work would take the methods developed further and produce both qualitative and quantitative results. This could be done by taking the mean and standard deviation of survey results and then writing a code which will allow for "random" survey results to be generated based on the mean and standard deviation. Running this script multiple times will then allow for different input values for risk each time. By running for 100, 1000 or 10000 iterations will then lead to increased accuracy of results and an agreement of which risk could be considered most critical. It will also allow for results to be expressed as a percentage to which the results agree. This could be taken a step further again by creating a 3D matrix of input which would include frequency of results as well, further increasing the accuracy of the final output value.

Each risk would be considered in more detail, with numerical values being assigned to the criticality of each risk based on past experience of similar industries. This data can be updated further as more wave and tidal projects begin to enter the market.