COMPETITIVE PRODUCT PRICING, EXTENDED PRODUCER RESPONSIBILITY, SUSTAINABILITY AND THE CIRCULAR ECONOMY

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ABSTRACT

In an increasingly competitive marketplace selling products at the most competitive price is the norm, however emerging trends towards extended producer responsibility (EPR), sustainability and the circular economy have augmented the traditional pricing model. This paper contributes to literature by identifying a research gap relating to product pricing models, EPR and the needs of sustainability and the circular economy. The research reported was designed to address how theoretical and real-world models could potentially work to address the research gap.

Keywords: competitive pricing model, extended producer responsibility, circular economy, sustainability**.**

INTRODUCTION

Diminishing natural resources, increasing raw material prices, increased automation and heightened consumer / political awareness of environmental impacts of manufactured goods, has led to the increased need to adopt sustainable manufacturing methods. The methodology employed is then described. The literature review then describes literature on (1) classical pricing models; (2) globalisation of trade and industry affecting price; (3) evolution of accounting cost models; (4) extended producer responsibility (EPR); (5) cost impact of chemical regulations; (6) sustainability and the circular economy; (7) industry 4.0. This is then followed by the propositions arising from the study. The paper is then concluded with a discussion, assessing implications, limitations and potential further research.

METHODOLOGY

A three-step methodology approach was used based on (1) literature review; (2) expert interviews with different manufacturing companies; (3) Online questionnaire posted on LinkedIn during November 2017 (Takhar, 2017).

FINDINGS

Classical pricing models

Classical economists (Smith and Skinner, 1982) argued pricing emerged from the process of bartering, exchanging one article for another, to achieve some form of gain. The economic pricing model (Smith and Skinner, 1982) is based on market supply versus market demand, against the level of competitors within a market place determines the natural product pricing. The 20th century saw the emergence of mass production at the lowest possible cost, selling at most acceptable market price. Additional wholesale and retail distribution layers evolved, which in turn affected pricing models. (Henderson, 1989; Porter, 1980; Skinner, 1978; Johnson and Scholes,

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1988; Chandrasekaran et al, 2013) Identified the need to change pricing strategies to include: (1) cross-functional inputs; (2) assess the state of competition (market forces); (3) consider supply chain impacts (value chain); (4) level of technology; (5) adjust according to the state of product life cycle state (introduction, growth, maturity, decline). (Table 1) Identifies pricing models and strategies to gain consumer adoption, satisfaction and loyalty (Papi, 2017; Chana, Narasimhana, Yoonb, 2017).

TABLE I. PRICING MODELS / STRATEGIES

Pricing Model	Description	Methodology / Comments	Source(s)
Raw material price.	Raw materials = materials converted in manufacturing.	(direct material cost + direct labour + in-direct costs) x2	(Merriam-Webster Raw Material, 2017)
Manufacturing price.	Manufacturing cost of a product.	(raw material price + direct labour + in-direct costs) x2	(Manufacturing Costs wiki, 2017)
Wholesale price.	Price of products sold by a wholesaler.	(manufacturing price + direct labour + in-direct costs) x2	(Business Dictionary Wholesale price, 2017)
Retail price.	Seen as the price charged to end consumers.	(wholesale price) x 2 Price model can be affected market supply and demand reaching natural product price.	(Collins Dictionary Retail Price, 2017)
Cost-plus (full-cost) pricing.	Production costs calculated with a profit margin applied.	(production costs / 100) (100 + mark-up) Assume production costs and % mark-up. Does not factor competitor pricing or market acceptance of natural product price.	(Cost-Plus Pricing wiki, 2017)
Penetration pricing.	Products are sold at cost or a loss, to gain a strong market share.	Sell product at less than cost price. Once market share gained, product prices will increase to generate a profit.	(Spann, Fischer, Tellis (2015))
Skimming / Premium Pricing.	The direct opposite of penetration prices.	Apply premium to product. Works if strong consumer loyalty to a brand. A premium price is applied to a product to induce notion of superior product.	(Spann, Fischer, Tellis, 2015)
Competition pricing.	Pricing is based the price of competitor products.	Same as similar products on market place.	
Promotional price.	Established products price reductions to gain market share.	Temporary price reduction. Reduced profit margins because of lower product prices. Attracts consumers to products which are either at maturity or declining growth state.	
Marketing price competition.	Two companies with similar costs and product.	Set aspirational price Use marketing to create consumer towards aspirational price.	(Papi, 2017)

Globalisation

Globalisation is defined as the mobility of goods, services, commodities, information, people and communications across national frontiers (Hopper, Lassoud, Soobaroyen, 2017). Products today are available from the global marketplace with global low-cost manufacturing supply and distribution networks, leading to flows of cheaper products disrupting the traditional pricing models. Traditional global brands evolved gradually developing brands, market leadership and minimizing risks with strong process controls. Born-Global (BG) companies (Nemkova, 2017) emerged (1) more agile; (2) less formal controls; (3) not averse to taking risks.

Evolution of cost accounting

Traditional cost accounting is referred to as the bottom line (Cambridge Bottom Line, 2017) where data will show either a profit or a loss. The aim of cost accounting is to ensure costs are identified and managed, to ensure profit between cost of manufacturing and the sales price. (Table 2) identifies different cost accounting methods. (Ponisciakova, Gogolova, Ivankova, 2015) Identified additional factors which need to be considered (1) increased automation; (2) continual performance improvements; (3) technological innovations; (4) shorter product life cycles; (5) support activities which augment traditional costing models. Triple bottom line accounting (Triple bottom line wiki, 2017) is based on 3 elements (1) traditional financial cost; (2) socially beneficial practices towards people and society; (3) environmentally sustainability. Cost accounting has adapted to changing market conditions observing a wider range of cost types.

TABLE II. COST ACCONTING MODELS COMPARED

Name	Description	Source(s)
Traditional cost accounting.	Traditional cost accounting focused on valuing inventory (raw materials, work in progress, finished products) and the cost of direct labour only.	(Cooper and Kaplan, 1988), (Ponisciakova, Gogolova, Ivankova, 2015)
Activity Based Costs (ABC).	ABC identifies activities and assigns a cost to each activity. ABC assigns more indirect across direct costs, to present an aggregated cost model, compared to traditional cost accounting. ABC assumes resources (physical or process based) are assigned to activities. Activities are then assigned to cost object then assessed based on consumption rates.	(Cooper and Kaplan, 1988), (Ponisciakova, Gogolova, Ivankova, 2015)
Absorption Costing (AC).	AC gets confused with FCA, however it does differ slightly. AC treats all costs involved in the production of a product to be product costs	
Full Cost Accounting (FCA).	FCA calculates costs based on all costs, this includes all fixed and variable costs (raw materials; direct labour; in-direct costs; machining costs; energy consumption; etc.). FCA factors in all costs to generate total cost per product or process	(Jasinski, Meredith, Kirwan, 2015), (Boër, C.R, et al, 2013)
Environmental Full Cost Accounting (EFCA).	EFCA extends FCA by analyzing environmental, economic and social impacts.	(Jasinski, Meredith, Kirwan, 2015)
Sustainability Assessment Modelling (SAM).	SAM extends FCA using performance indicators in a 4-step process: (a) social progress; (b) environmental quality; (c) economic prosperity and (d) resource availability. Each indicator, requires identification, focus, measurable focus across a project/product lifecycle.	(Jasinski, Meredith, Kirwan, 2015), (Boër, C.R, et al, 2013)
Material Flow Cost Accounting (MFCA).	MCFA concerns material and energy costs. MFCA measures materials within a manufacturing system in terms of physical stock and monetary value. Materials are defined as raw materials, WIP, component part and finished products. MFCA cost analysis compares the cost of products against the costs of materials losses.	(Guenther, et al, 2015), (Prox, M, 2015), (Wagner, 2015), (Schmidt, Götze, Sygulla, 2015), (Kokubu, Kitadab, 2015), (Christ, Burritt, 2015), (ISO 14051:2011, 2011)
Life Cycle Assessment (LCA).	LCA looks at the product in terms of costs to the environment via identification of resources consumed and the impacts of those resources.	(Bierer, A., et al, 2015)
Life Cycle Costing (LCC).	LCC examines product life cycle in terms of economic consequences (material costs, energy costs, distribution costs, disposal / recycle costs, revenues) and monetary trade-offs.	(Bierer, A., et al, 2015)

Cost impact assessment of regulations

Regulations exist to present society with a set of rules to maintain a consistent set of norms. Chemical regulations (Regulation of chemicals wiki, 2017; EC WEEE, 2017; EC ELV, 2017; EC RoHS, 2015; EC Packaging and Waste, 2017; EC Eco-Design Directive, 2005; EC REACH, 2017) look to extend these norms, by ensuring hazardous chemical substance usage is identified, tracked and where applicable controlled, restricted, labelled, packaged and safely disposed. The costs of the regulations may not be known at the time of manufacture or when a new piece of regulation is implemented, producers do need to understand the impacts of these regulations (Table 3).

TABLE III. REGULATIONS WHICH CAN AFFECT COSTS

Name of Regulation	Details	Applicable Industry / Industry	Sources(s)
Batteries.	Directive 2006/66/EC Directive 91/157/EEC	Battery regulations - Europe but affects Global supply.	(EC, DG Environment, 2014)
ECO Design.	Directive 2005/32/EC	Electrical regulations - Europe but affects Global supply.	(EC Eco-Design, 2005)
End of Life Vehicles.	Directive 2000/53/EC	Automotive regulations - Europe but affects Global supply.	(EC, DG Environment, 2014)
EU Restriction on Hazardous Substances.	Directive 2015/863/EC Directive 2011/65/EU Directive 2002/95/EC	Electronics regulations - Europe but affects Global supply.	(EC, DG Environment, 2014), (EC, 2015)
REACH.	Regulation (EC) No 1907/2006 Directive 2006/121/EC	Multiple industries - Europe but affects Global supply.	(EC REACH, 2017)
Waste Electronics and Electrical Equipment.	Directive 2012/19/EU	Electronics & electrical regulations - Europe but affects Global supply.	(EC, DG Environment, 2014), (EC WEEE, 2017)
Packaging and Packaging Waste.	Directive 2004/12/EC Directive 97/62/EC	Packaging and packaging regulations - Europe but affects Global supply.	(OECD, 2016), (EC Packaging and Waste, 2017)
Waste Framework.	Directive 2008/98/EC	Waste regulations - Europe but affects Global supply.	(OECD, 2016), (EC Packaging and Waste, 2017)

Extended producer responsibility (EPR)

The aims of EPR (OECD, 2001; OECD, 2016) are to encourage producers to design products which: (1) last longer in use; (2) reduce the amount of hazardous materials being sent to waste sites; (3) can be recycled more efficiently; (4) develop trade-in or upgrade schemes; (5) recycle products to enable producers to gain access to secondary raw materials, specifically for their own supply chains. EPR makes producers consider both product life cycle and circular economy factors. (Wagner, 2012) Presents using EPR and Product Stewardship (PS) techniques into laws for managing waste: (1) manned collection points; (2) reasonable access to collection points; (3) retail take back; (4) reduction of physical barriers (5) mail back programs. (EPR wiki, 2017; EC, DG Environment, 2014) Examined EPR schemes for EU WEEE and packaging directives, producers worked collaboratively to create industry collection schemes, paying a fee based on the amount of product placed onto the market place. The fee is used to fund collection and recycling processes, (OECD, 2016) identified 400 EPR schemes. (Table 4) shows the impact of EPR by

product types globally, recycling rates, and regional distribution. (OECD, 2016; EC, DG Environment, 2014) identified a lack of clear and consistent data in identifying the impact of EPR systems. Future state EPR analysis requires data to more easily identifiable, extractable in formats to allow data aggregation. (OECD, 2016) identified only 45% of EU packaging waste has been identified by an EPR scheme. There are considerable amounts of waste not covered by an EPR scheme, global EPR implementations are shown in (Agrawal, 2014).

TABLE IV. GROWTH IN EPR USAGE BY PRODUCT TYPE GLOBALLY

Product Type	**Source**	**Source**	**EPR Regional Distribution**	**Most Effective Recycling Rates**
	(Agrawal, 2014)	(OECD, 2016)	(OECD, 2016)	(EC, DG Environment, 2014)
EPR by product type				
Electronics	-	35%	-	-
Tires	-	18%	-	-
Vehicles / Auto batteries	-	12%	-	-
Packaging	-	17%	-	-
Other	-	18%	-	-
EPR by scheme type				
Take-back	70%	-	-	-
Deposit / Refund	11%	-	-	-
Advanced Disposal Fees	17%	-	-	-
Other	2%	-	-	-
EPR by recycling rates				
Overall EPR	-	-	-	Belgium, Germany, Netherlands, Czech Republic, Austria
Battery Recycling	-	-	-	Switzerland, Belgium, Austria, Denmark
ELV	-	-	-	Finland, Netherlands, Austria
Graphic Paper	-	-	-	Finland, Netherlands, Sweden
Oils	-	-	-	Belgium, Italy, Finland, Germany, Portugal
EPR regional distribution				
North America	-	-	48%	
Europe	-	-	42%	
Asia	-	-	4%	
Rest of the world	-	-	6%	

Sustainability and the Circular Economy

Sustainability can be described as producing products that do not contain scarce resources or incur damage to the environment (Cambridge Sustainability, 2017). UN Sustainable Development Goals (SDG's) (UN Goal 12 targets, 2017) have prompted industry to observe a role in global sustainable development. UN SDG 12 'Responsible Consumption and Production' describes the need for sustainability by a producer to implement a framework of activities to manage waste. Sustainability frameworks (Ahmadi, Kusi-Sarpong, Rezaei, 2017; Dizdaroglu, 2017; Krajnc, Glavic, 2005) provide a basis for analysis: (1) pre-implementation; (2) post-implementation costs (new raw materials, energy consumption, waste) are considered in alignment with benefits of an approach versus the economic gain from a new product versus an old product. Industry needs to produce products that provide environmental and social benefits. The circular economic system

extends both traditional linear economic system and sustainability by minimizing waste and maximizing reuse of scarce materials. In a circular economy: (1) producers use new raw materials to produce products, with waste reused as much as possible; (2) new products are then purchased by consumers; (3) consumers return products after use for repair / servicing / disposal; (4) producers either renew / repair the products for extended use; (5) where a product cannot be repaired, a recycling process shall extract materials into secondary raw materials; (6) where products cannot be recycled any further, the waste shall be disposed of in an environmentally friendly manner; (7) secondary raw materials will be used to produce new products in the production cycle. (EASAC, 2016) compared water and energy consumption rates within an initial production cycle in comparison to recycling of materials, use of recycling showed a marked reduction in environmental impacts. The EU (EU Horizon 2020 Project, 2017) has launched its programme of activities to support the UN SDG's, moving towards the circular economy model.

Industry 4.0

Industry 4.0 (Industry 4.0 wiki, 2017) will see further advancements due to automated triggers from consumers and systems (automating alerts for repair / replacement of products) generating demand on the manufacturers. With increasing scarcity of raw materials, reducing waste and moving towards sustainable manufacturing, industry 4.0 should bring further enhancements to sustainability and the circular economy.

Expert Interview Analysis

The same questions were used in the expert interviews and the on-line questionnaire. 8 expert interviews were conducted between July to September 2017. (Table 5) shows the results of the expert interviews. The key findings: (1) lack of awareness relating to product cost and product pricing models; (2) an appreciation of costs elements which should be included with the cost / pricing model; (3) critical materials identified tantalum, lithium, cobalt, gold, silver and tin; (4) the most common level of recycling was seen as 11-30%; (5) the highest values for EPR schemes were seen as trade-in and product ownership schemes; (6) in terms of costs to includes within a new cost model: new raw material prices, trade-in schemes, compliance costs, supply chain costs and ownership schemes scored highly; (7) The top 3 ranked factors for achieving sustainability were seen as: strong leadership, regulatory environment and increasing internal control measures; (8) The respondents came from aerospace and defence, electronics and manufacturing industries; (9) respondents were located in Europe and north America.

On-Line Questionnaire

The on-line questionnaire (Takhar, 2017), using the same questions was placed on LinkedIn during November 2017, 52 completed responses were received. (Table 5) shows the results of the online questionnaire survey. The on-line questionnaire showed similar results to the expert interviews for (1) awareness of product cost model; (2) awareness of product pricing; (3) levels of recycling. The on-line questionnaire differed in terms of (1) identifying common cost elements; (2) awareness of elements which should be contained within pricing model; (3) a much wider range of critical materials; (4) in terms of EPR trade in schemes, regulations, deposit schemes and ownership were viewed as most important; (5) a greater range of costs were returned, which could be incorporated into a cost model; (6) respondents came from a wider range of industries and (7) locations.

TABLE V. EXPERT INTERVIEW AND ON-LINE QUESTIONNAIRE SUMMARY

Area	Responses	Expert interview responses	Online responses
Awareness of current product cost model.	Yes	3	24
	No	5	28
Most common costs elements which should be considered in a product cost model.	Raw material prices	6	43
	Direct labour costs to manufacture goods	6	43
	Cost of renewed or recycled materials		27
	Packaging costs.	4	19
	Cost of machinery.		12
	Energy consumption costs.	5	12
	In-direct labour costs.	2	8
	Energy consumption costs.		8
	Depreciation charges for buildings and machinery.		7
	Transportation costs (good to market)		7
	Environmental costs.		3
	Cost of compliance to regulations.		3
	Product research and development costs.		2
	Renewal costs to reprocess waste materials.		2
	Disposal cost of waste removal.		2
	Cost of certifications (if any).		1
Awareness of current product pricing model.	Yes.	3	21
	No.	5	31
Most common costs elements which should be considered in a product pricing model.	Raw material prices (new).	7	40
	Direct labour costs to manufacture goods.	7	40
	Cost of renewed or recycled materials.	3	35
	In-direct labour costs.		29
	Product price should be lower than competition.		26
	Premium product allows for higher price being charged.		22
	Packaging costs.	4	22
	Energy consumption costs.		12
	Cost of manufacturing site(s).	4	11
	Depreciation charges for buildings and machinery.		11
	Wholesaler and retailer profit margins.		11
	Cost of machinery.	5	10
	Product research and development costs.		10
	Environmental costs.		9
	Cost of certifications (if any).		8
	Renewal costs to reprocess waste materials.		8
	Disposal cost of waste removal.		5
	Cost of compliance to regulations.		3
Most commonly identified critical	Tin.	5	29
	Gold.	5	27
	Cobalt.		26
	Silver.	6	24

Area	Responses	Expert interview responses	Online responses
materials.	Copper.	5	22
	Chromium.	4	22
	Rare Earths.		21
	Tantalum.	7	20
	Lead.		18
	Manganese.		17
	Lithium.	7	15
	Magnesium.	6	14
	Tellurium.		14
	Tungsten.	4	12
	Iridium.		12
	Cadmium.	3	12
	Platinum.		11
	Nickel.		11
	Aluminum.	4	10
	Hafnium.		10
	Gallium.		9
	Germanium.		9
	Beryllium.		7
	Molybdenum.		7
	Graphite.		6
	Antimony.		5
	Indium.		5
	Osmium.		5
	Rhodium.		5
	Helium.		4
	Niobium.		4
	Palladium.		3
	Ruthenium.		2
	Zinc.		2
	Arsenic.		1
Most common levels of recycling identified.	51 to 60%.		2
	31 to 50%.	1	6
	11 to 30%.	4	21
	Less than 10%.	2	17
	Unknown.	1	6
Most common EPR actions on manufacturers.	Deposit schemes.	3	28
	Trade in schemes.	6	38
	Ownership - Manufacturer maintains ownership.	5	23
	Regulations.	4	31
	Collection schemes.	2	18
Costs which should be incorporated into a new cost	Land use.	1	8
	Health and safety costs.		38
	Compliance costs.	5	38
	Supply chain costs.	5	42

Area	Responses	Expert interview responses	Online responses
model.	Employee rights.		23
	Human rights.		16
	Raw material prices (new).	6	21
	Renewable and recyclable.	4	21
	Deposit schemes.	3	24
	Trade in schemes.	6	24
	Ownership schemes.	5	21
	Collection schemes.	2	9
	Consumer use.	1	18
	Environmental impact assessment.	2	21
	Consumer education costs.	2	12
	Regulations.	4	16
Ranking of important factors for business to achieve sustainability goals [Answers were on a ranking scale].	Strong leadership desire towards becoming more sustainable.	1	1
	The regulatory environment moving towards increased reuse and recycling (circular economy).	2	3
	Increasing internal control measures produce less waste.	3	5
	Increasing consumer trends towards using environmentally safe products.	4	6
	Financial stability within the business to absorb the development costs to support sustainability.	5	2
	The expertise of key people within the business to support sustainability efforts.	6	4
	Cultural acceptability of using reused/recycled materials.	7	9
	Supply chain buy in to reduced waste and recycling to bring about secondary material usage	8	8
	Diminishing material supply causing the need to reuse and recycle materials.	9	7
Respondent industry question.	Aerospace and Defence.	4	9
	Agriculture and Food.		3
	Chemical and Pharmaceutical.		7
	Computing.		3
	Construction.		4
	Consultancy Services.		2
	Electronics.	2	4
	Energy.		3
	Financial Services.		1
	Information Technology.		2
	Manufacturing.	2	10
	Regulatory Compliance.		2
	Telecommunications.		1
Respondent location question.	Europe.	6	23
	North America.	2	18
	South America.		4
	Asia.		6

CONCLUSIONS

Summary

Fundamentally business exists to generate economic gain through the sale of goods and/or services. Increasing threats from existing competitors and/or new entrants resulted in the need for competitively priced products which meet market expectations. Mass industrialization resulted in both increased environmental impacts and diminishing critical materials. Globalisation opened markets to new entrants via on-line channel distribution methods has eroded traditional pricing and distribution models. Increasing environmental regulations have imposed stricter controls on industry, which impacts upon the business cost model. Industry must ensure compliance by identification of material usage within a supply chain, then take actions: (1) customer declarations; (2) import notifications; (3) safe use guidance; (4) requesting approval for continued use; (5) look for alternative materials where additional controls are enforced against a given material. EPR has placed additional obligations on producers to act in a responsible manner in both product design and the collection and recovery of materials from end of life products. The aim of sustainability it to produce highly durable products, which require less repair, servicing ultimately eliminating the need for replacement products, moving towards the circular economy. The circular economy will aim to reuse as much as possible, this should result in much larger waste reduction, recycling to return materials back into the production cycle. Thereby minimizing the need to absorb new materials. Moving towards the path of sustainability and the circular economy requires additional investment, for some industries where the use of scarce materials is a given, it will become a necessity. For other industries as material prices rise over time, it will become more attractive over time. Producers must adhere to maintaining the balance between lowering costs, to remain competitive whilst managing the costs meet regulation, recycling and renewal of products.

Contributions to theory

The purpose of this paper was to examine correlations between competitive pricing and factors such as EPR, sustainability and the circular economy: (1) traditional cost and pricing models may be inaccurate based on the requirements for sustainability, EPR and the circular economy; (2) newer cost accounting models such as EFCA, SAM, MFCA, LCA and LCC offer different options for recording costs. No one model excels above another, the producer needs to develop cost recording systems as most applicable to their business; (3) sustainability frameworks do exist, however they are geared towards the environmental, social benefits, and economic benefits of products, as opposed to developing accurate cost reporting, reflecting accurate product pricing; (4) respondents showed an understanding of costs which should be factored into cost and pricing models; (5) Key factors for sustainability were (a) strong leadership; (b) regulatory environment; (c) financial stability; (6) producers should regularly revalidate cost and pricing models to ensure profitability is maintained.

Further research extensions

The expert interviews / on-line questionnaire could be extended in future research by examining understanding and awareness of (1) UN SDG implementations geographically and within an industry setting; (2) recycled materials which have been recycled (not product) to build a picture of which materials are readily available as secondary materials; (3) further interrogation of product pricing in relation to chemical regulations. In hindsight reducing the number of questions and size of answers in the questionnaire/survey design may have increased the number of responses. The final research extension would be to create a sustainability framework that factors in product costs,

product pricing in relation to analyzing the economic, environmental and social benefits for a producer.

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