
The Red Queen Effect (RQE) on Business and the Role of Generative AI in Industry 5.0

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Abstract:

Purpose: The aims of this research paper are bifold firstly, it attempts to identify the contributions of the RQE theory and secondly, to enable corporates to evade the Red Queen Effect by using generative artificial intelligence to be prepared for Industry 5.0.

Design/Methodology/Approach: The red queen effect is a metaphor used in the business world to describe the unsuccessful efforts of a company to get ahead of its competition. The red queen effect is the need to continually adapt and evolve to maintain relevance in an ever-changing environment. Companies must constantly innovate and find new ways to stay ahead of the competition to ensure their survival and success. Companies typically research or study the competition and then implement strategies to help boost their company sales and profits. This is an effective and practical method of outmaneuvering the competition.

Findings: The use of SD enables GAI to expand CP beyond short-term adjustments and actions, empowering businesses to foresee and create content that takes into account projected future customer preferences and behaviours which seeks to solve the requirement of so-called sustainable consumption patterns by providing the answer in the form of customers mass customization which can be used by the companies to avoid red queen effect currently prevailing in their respective industries thus getting ahead in race of competition and preparing them for future industry 5.0.

Practical Implications: While this technique works in theory, companies might not achieve their goals because the competition engages in the same business practice. Despite a company's efforts to surpass the competition, the company does not move forward or grow.

Originality/Value: The research is only of its kind solution to Red queen effect faced by companies in current Industry 4.0.

Keywords: Red Queen Effect, generative AI, industry 5.0, sustainable consumption pattern, customer personalization.

JEL Classification: O33, O32, M25, L21, M20.

Paper type: Research article.

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1. Introduction

The term Red Queen Effect (RQE) was first used by the biologist Van Valen (1973). The metaphor comes from a passage from *Through the Looking Glass* by Lewis Carroll, the sequel to *Alice in Wonderland*. In the book, the Red Queen tells Alice: “Now, here, you see, it takes all the running you can do to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that!” (Carroll, 1965). This metaphor enabled Van Valen (1973) to explain certain biological behaviours and to analyse how species continually adapt to their environment to stay ahead of their competitors, which are also continually adapting.

The choices which the RQE offers to species is simple: do nothing and be overtaken or fight to keep your position. Like the examples from the living world, we can use similar reasoning for organisations developing in competitive environments, where the RQE is described as “competitive rivalry in which firms must increase their investment in order to maintain their existing market position while at the same time failing to earn returns that are commensurate with higher investments” (Lampel and Shamsie, 2005).

The RQE creates a link between organisational learning (March, 1988) and organisational ecology (Hannan and Freeman, 1989), which distinguishes it from the work of the Austrian school and the Schumpeterian approach. As Barnett and Sorenson argue (2002), “(i) competition among organisations triggers internal organisational ecology; (ii) learning increases the strength of competition generated by an organisation.”

When combined, learning and competition gradually reinforce one another as the organisation develops, giving rise to a self-reinforcing RQE process. The mutual learning that takes place between competitors is another reason why the competitive advantage can only be temporary. When a firm survives competition, it increases its operating capacity, making it better adapted to its environment (Barnett and Sorenson, 2002; Barnett and McKendrick, 2004; Barnett, 2008).

As Barnett and Hansen (1996) indicate, “greater resilience would increase an organization’s performance”. Even if the competitive advantage disappears in the long term, only continual adaptation can enable organisations to maintain their level of performance, even temporarily (Venkatraman and Henderson, 1998).

Based on a study on the performance of over 400 companies over a thirty-year period, Beinhocker (1997) argues that it is hard for firms to maintain a level of performance above that of their competitors for more than five years. Enhanced long-term performance is not so much due to a distinct competitive advantage but can rather be achieved by continually evolving and adopting new sources of temporary advantage that enable them to stay ahead in the race.

On the other hand, companies that adopt competitive behaviour based on imitation risk focusing exclusively on the competitors' behaviour to the detriment of real strategic thinking and the exploration of new capacity (Barnett and Hansen, 1996; Barnett and Pontikes, 2008; Lampel and Shamsie, 2005). Such firms are likely to fall into a "competency trap" that prevents them from developing new solutions (Levinthal and March, 1981; Levitt and March, 1981).

Working "differently" seems to be an intuitively suitable approach for survival or even prosperity in the present era's increasingly competitive business landscape. Companies need to change industry rules (the accepted way of doing business in the industry) by fundamentally questioning their tendency to conform to useful but "unoriginal" (copied, imitated, improved) practices, lessons, and experiences. But, how can managers and their organizations accomplish this?

That is, how can companies broaden and update their approaches and way of thinking to include the fundamental factors that influence the creation of successful new business models? The aims of research paper are bifold firstly it attempts to identify the contributions of the RQE theory and secondly to enable corporates to evade the Red Queen Effect by using generative artificial intelligence to be prepared for Industry 5.0.

2. Literature Review

A detailed contribution of the RQE theory in literature is shown in Table 1.

Table 1. *Contributions of the RQE theory*

Reference	Variables	Results	Contributions	Method
Barnett et al., 1994	Corporate performance (ROA) Competitive position Internal competencies (age, size, activities, etc.)	Competition is beneficial to single-activity firms due to the learning impact and does not benefit multi-unit firms.	Proposal for a co-evolutionary model which enables the link to be made between the firm's internal and external advantages	Quantitative study on 1109 retail banks in Illinois between 1987 and 1993
Barnett & Hansen, 1996	Failure rate of organisations	Positive impact of recent experience on the survival rate of organisations, unlike longer-term experience Higher survival rate when the organisation is confronted with very different competitor cohorts	Identification of conditions in which the RQE may be relevant or not	Quantitative study on 2970 retail banks in Illinois between 1900 and 1993

Barnett, 1997	Failure rate of organisations Rate of creation Population density	Large firms gradually become less and less competitive, unlike smaller firms, thereby reducing their capacity to survive	Proposal of a model that identifies the environmental effects of organisational characteristics in order to explain the RQE process	Quantitative study on the beer sectors in the US from 1663 to 1988, and the phone sector in Pennsylvania from 1879 to 1935
Barnett & Sorenson, 2002	Rate of creation Growth rate	Identification of positive effects (rapid growth, competitive pressure, emergence of barriers to new entrants), and negative effects (competency trap) due to the RQE in an industry	Combination of ideas and models on the theory of organisational learning and organisational ecology with respect to the RQE	Quantitative study on 2970 retail banks in Illinois between 1900 and 1993
Barnett & McKendrick, 2004	Size of company	While large organisations lead the race at the technological level, they gradually become less competitive than the smaller firms	Distinction between two ideas of competition: competition as a race which favours large organisations and competition as a constraint that favours small organisations	Quantitative study on 1538 firms in the hard disk sector between 1956 and 1998
Barnett & Pontikes, 2005	Firm's experience Firm's performance (ROA)	Summary of work by Barnett and Hansen (1996) and by Barnett and Sorenson (2002)	Study showing that competition between organisations depends on history	Quantitative study on 1538 organisations in the hard disk sector between 1956 and 1998 and on 2970 retail banks in Illinois between 1900 and 1993
Lampel & Shamsie, 2005	Amount of sales generated by the studio for each film	Comparison and imitation of strategies adopted by film studios, even if it results in poorer performance	Identification of the cognitive dimension of the RQE in response to the complexity of multi-point competition	425 films spread evenly between 1990-1991 and 2000-2001
Barnett & Pontikes, 2008	Competitive experience Failure rate Rate of market entry	Organisations with competitive experience are more viable in their specific market and	Identification of the role of the RQE in the likelihood and impact of	Quantitative study on 2602 firms from the IT sector in the United States

		less so when they penetrate a new market	organisational change. While exploration is considered as	between 1951 and 1994
Derfus, et al., 2008	Focal corporate actions and competitors (price, capacity, geography, marketing, new product launch) Speed of competitors' reactions Corporate performance (ROA and ROS) Sector conditions (Herfindhal index, rate of growth in the industry), Competitive position (market share per year)	The actions of an organisation enhance its performance but also the amount and speed of reaction of its competitors, who, as a result, negatively impact the performance of the focal organisation. The effects of RQE depend on the situation in the sector in question and the competitive position of the focal firm	Identification of three RQE moderating factors (the level of concentration in the sector, the level of demand and the firm's market position)	Quantitative study on 4700 corporate actions from 11 industrial sectors in the United States
Barnett, 2008	Rate of failure Rate of creation Competitive logic	Organisations which outlive the competition become stronger, but only in their market sector The level of an organisation's competitiveness depends on its experience The weakest competitors fail, stepping up the competition and strengthening surviving firms in a dynamic evolutionary process	Identification of the positive and negative impacts of the RQE	Quantitative study on 1538 firms in the global hard disk industry between 1956 and 1998 and on 2970 retail banks in Illinois between 1900 and 1993

Source: Own study.

3. The Red Queen Effect as a Comfort Trap

In situations where the business environment is characterised by discontinuity and uncertainty, companies may find themselves trapped in a “catch-22” situation of learning ways that solely protect and improve their current businesses rather than experimenting with new ways that change the “rules of the game”. While most established (incumbent) companies are busily engaged in competing with similar/comparable competitors, (mainly) entrepreneurial ‘upstarts’ and new entrants to an

industry capture the bulk of the customer base and niche of the existing (or newly created) market. This is largely due to upstarts' lack of awareness, familiarity, understanding of, or conformity to the already learnt and established way of doing business in the industry, and the subsequent fresh (different) perspectives and disruption they bring to the industry.

A classic example of a company that was wedged in a Red Queen trap is Encyclopaedia Britannica. From being regarded as the world's most comprehensive and authoritative encyclopaedia in the early 1990's, with the industry's most efficient and successful direct salesforce, it was swiftly relegated to being sold at less than half of its book value. And all this was due not to competition from a traditional counterpart, but a new rival – the CD-ROM (Evans and Wurster, 2000).

Another example is the MP3 phenomenon that has changed the recording industry. As a freely available technical standard for the compression and transmission of digital audio, it was suddenly possible to download entire collections of pirated music and albums using the Internet. This has already been costing the music industry billions of dollars, and no matter how the recording industry scrambles to be in control again, the rules of the game have already been irrevocably changed (Evans and Wurster, 1997; Tapscott *et al.*, 2000).

Sears, Roebuck & Co., once one of the world's largest organizations and America's leading retailer, is another example of a company that was unable to respond early to the threats posed by discount department stores such as Wal-Mart, K-Mart and Toys-(z)-Us. Sears was in the catalogue business (thereby extensively ignoring online business for a long time) and had drifted to a condition of denial and complacency reactions of "too small to worry about" or "not a problem in my region". It was 'too little too late' by the time Sears included Wal-Mart and others among its competitor benchmarks (Pascale *et al.*, 1997).

The airline industry offers another example of new entrants that have disrupted established business practices. Compared to traditional network airlines, budget airlines have managed to lower their costs and fares, thereby undermining the dominance of the traditional hub-and-spoke mainstream network.

Although big airlines are learning key techniques from their competitors in having cost advantages (and still receiving subsidies from their governments), they have mostly not perceived that the new competition is not based merely on cost and service innovations, but on entire new business models that involve new types of customers, new value propositions, new network configurations, and new capabilities.

As a result, they will have to reinvent their business models or go out of business (see e.g. The Economist, 2004 for a review of major impacting forces on traditional airline businesses). The above examples demonstrate instances where established

companies continue to do what they have “learnt” to do in the past and failed to properly respond not only to technological changes but also to competitors and customers that initially seemed irrelevant to their respective businesses.

Even if the incumbent companies were aware of those changes, they probably found it difficult to pre-emptively cannibalize or destroy still profitable businesses and cut off long-term relationships with their existing suppliers and customers – Christensen’s (1997) well known “innovator’s dilemma”. Nevertheless, it is a managerial dilemma organizations need to address for their continued sustainability and long-term performance.

This is not to mean that organizations have to completely unlearn, cannibalize, and even destroy what they have invested in perfecting, but rather to broaden their mindset to recognize and embrace the disruptive changes that take place in the continuously shifting business landscape, and to be able to develop proactive capabilities to handle such situations. For companies engaged and perhaps ‘locked’ in a Red Queen race, sustainable competitive advantage comes to those who move beyond focusing on existing situations (competitors, customers, markets, supply chain configurations, etc.), to appropriately make sense of the holistic/systemic business landscape and accordingly reinvent their business models.

4. Industry 5.0

There are various different visions for Industry 5.0. Some futurists argue that while Industry 4.0 is essentially about connecting devices together, Industry 5.0 is about collaboration between humans and machines on the factory floors (Johansson, 2017). Gotfredsen (2016) lists the benefits of a collaborative man and machine workforce. There will be a creative human touch on the production instead of a standard robotic production. New jobs will be created. Human workers will assume better roles on the factory floor.

According to Østergaard (2016), Industry 5.0 is the return of the human touch on the factory floors. Rendall (2017) argues that while Germany leads the fourth industrial revolution, North America is uniquely positioned to lead the next industrial revolution – Industry 5.0. Rendall (2017) and many others share the vision of man-machine collaboration for the Industry 5.0.

Rowan *et al.* (2022) for example, argue that innovation in peatlands will be driven by digital solutions that include process automation, data analysis and processing, control and management systems. They present a rather human-centric consideration of Industry 5.0, in which these technological-driven activities align with the main principles of Industry 5.0, which puts people at the center, and with many of the UN's Sustainable Development Goals. Rowan (2022) also promotes a human-centric approach to Industry 5.0, in more detail the use of artificial intelligence (AI) and human-computer interfaces to solve global food chain issues.

Moreover, Rowan (2022) presents the concept of social marketing at the “interface of human and natural systems and their interconnected dynamic forces as a powerful means of influencing behaviors for the accorded transformation and betterment of individuals, communities, society and the planet”. In their more specific view of Industry 5.0, they instead stress the aspects of mass personalization, increased human-computer interaction as a means for social problem solving, and advancement from Industry 4.0 to Industry 5.0 (Kaklauskas, Lepkova, Raslanas, *et al.* 2021).

Dhawan *et al.* (2022) focus on technological elements such as transport optimization, data and information sharing, and collaboration for transport decarbonization to transition the current 4.0-construction industry to a 5.0 industry in New Zealand. Hence, they refer more to technological advancements regarding the achievement of sustainability goals. Orea-Giner *et al.* (2022) explore the relationship between clients’ emotions and sentiments created by the interaction with hotel robots and the possible effect on a hotel’s rating.

In their view, Industry 5.0 is the “enhanced experience of the final customer by applying the different tools available considering artificial intelligence (AI) and robotics”. Kaasinen *et al.* (2022) foster the focus on intelligence and resilience regarding next-generation manufacturing systems and human operators. They present three core elements of future Industry 5.0 factories, human-centricity, sustainability, and resilience, aligned with the European vision. Kaasinen *et al.* (2022) present a design approach in which human operators and smart machines form collaborative teams.

4.1 New Customer Value Proposition

New customer value proposition is one of the basic elements of a business model. Creating and offering new customer value proposition is the basis from which viable and successful business models can be created. Being the first to offer such value often gives a company “monopoly profits” by achieving high returns before competitors start to imitate and catch up.

Being an early mover in responding to environmental changes can also give a company major competitive advantage by creating a critical mass (Govindarajan and Gupta, 2001; Hitt *et al.*, 2001). For example, FedEx aimed to create a new customer value proposition by offering overnight delivery services. This strategy was feasible and succeeded to the point that industry incumbents were forced to adapt to the new industry structure and offer similar services (Courtney *et al.*, 1997).

The customer value proposition (CVP) is an important concept integrating theory and practice in business research and management. While recent studies have yielded important insight into the aspects of managing CVPs, an integrative approach is needed, for synthesis of understandings under a unifying framework.

4.2 How to Evade the Red Queen Effect by Using Generative AI: Preparing Companies for Industry 5.0

It is necessary to take advantage of the opportunities offered by the Industry 5.0 concept and formulate new marketing strategies in such a way as to enable sustainability and minimize the effects of excessive consumption (Fraga-Lamas *et al.*, 2021; Leng *et al.*, 2022; Saniuk *et al.*, 2022). The solution is to introduce new patterns of quality of life and the idea of well-being, especially in developed countries, consisting of, among other things, share economy, circular economy or personalization of production (products with an extended life cycle).

Hence, there is increasing talk of so-called sustainable consumption patterns, which is a form of consumption directly related to the concept of sustainable development, oriented towards long-term socio-economic goals, especially in terms of positive environmental impact (Promoting Sustainable Consumption, 2008; Ghobakhloo *et al.*, 2022). At the same time, the importance of the development of the Industry 5.0 concept for supporting consumer behavior oriented toward sustainable consumption was emphasized (Leng *et al.*, 2022).

Sustainable consumption patterns could only be developed through mass customization of products by the business firms. Chen *et al.* (2019) defines personalization as any customization of a product (its features, method of distribution and even promotion) to meet individual customer needs. Businesses are therefore required to respond quickly to customer needs, in terms of developing a personalized product, delivering the order in a timely manner and ensuring a low purchase price.

One of the modern forms of enterprise communication with customers is customization. Mass customization involves personalization of product offerings and services on a large scale, which is made possible by the rapid development of automation, robotization and digitization of production and logistics processes, as well as in-depth knowledge of consumer needs and preferences.

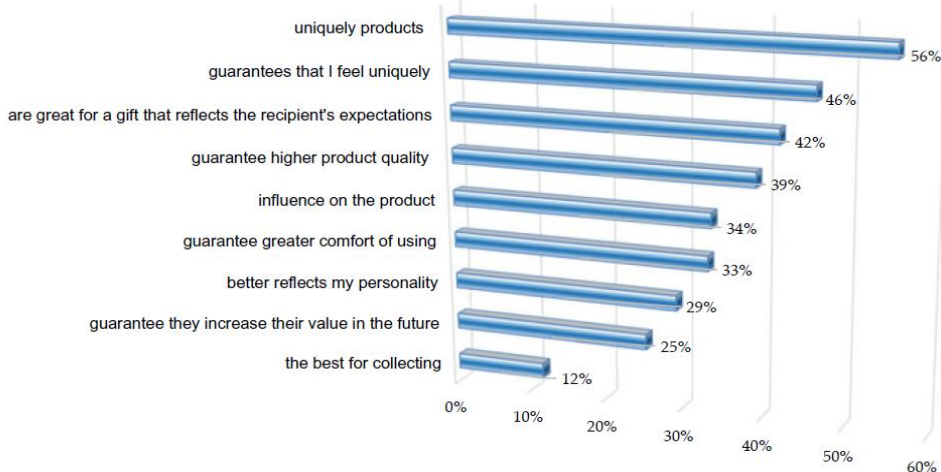
Its goal is to optimally meet consumer needs through better interaction during the process of designing new products (Suzi'c *et al.*, 2018). The main goal of customization is to produce customized products with production costs and price levels close to those of mass-produced products (Pallant *et al.*, 2020).

4.3 Generative Artificial Intelligence and Smart Data

According to Liu *et al.* (2023), GAI in marketing is increasing popularity as a result of developments in smart data mining models, big data availability, rising processing power, and declining computing costs. According to recent studies, the use of SD by GAI has produced CP analytics outputs such automated text analysis,

marketing insight and prediction, and customer preference assessment (Humphreys and Wang, 2018).

Figure 1. Main reasons for choosing personalized products.



Source: Grabowska and Saniuk, 2021; Saniuk et al., 2020.

In order for GAI to acquire smart data about customers, it must first locate and extract new and relevant customer information (i.e., SD) from enormous data sets using a technique called knowledge discovery (KD) or smart data mining (SDM). GAI can discover previously undiscovered characteristics, features, or connections within a set of consumer data by utilising a range of approaches. The study by Yau *et al.* (2021) indicates that in order for GAI to convert unstructured data into smart structured data and learn the SD for CP, GAI must go through all five levels of the 5Vs characteristics (i.e., velocity, volume, value, variety, veracity).

First, GAI gathers a sizable amount of customer and prospect-based data from a variety of digital platforms, including social media and IoT platforms.

Second, the GAI also produces a significant volume of customer-focused data at a rapid pace in real time.

Third, a wide range of customer information is recorded in formats like text, image, audio, and sensing results.

Fourth, the high veracity of customer data necessitates a high level of correctness and reliability, necessitating the processing of unstructured data into SD and the removal of extraneous data.

Fifth, increasing CP has the potential to have positive social and economic effects due to the high value SD generated by GAI.

4.4 Smart Data and Customer Personalisation

Structured and smart data (SD) are essential to customer personalisation (CP). As a result, gathering comprehensive SD about customers is the first and most important stage in the CP process. Purchase history, demographic information, online interaction behaviour, social media activity, and sentiment analysis may all be included in a detailed SD (El-Ansari and Beni-Hssane, 2023).

Deep learning (DL) technique that can be enabled by GAI are then used to examine this data in order to provide personalised customer experiences. According to Afshar (2023), customer data must be examined in order to yield actionable insight after being obtained with the aid of technology capabilities like IoT. This could entail locating customer patterns, tastes, and behaviours that can forecast upcoming personalisation activities.

The application of SD enables GAI to advance CP above immediate changes and actions, empowering companies to forecast and produce content that accounts for anticipated future customer choices and behaviours.

This includes designing customised promotional offers, individualised shopping lists, or distinctive customer experiences. By enabling GAI to further increase CP's proactiveness in this way, SD dramatically improves customer engagement, interactive marketing, value co-creation, and customer loyalty (Anshari, Almunawar, Lim, Al-Mudimigh, 2019).

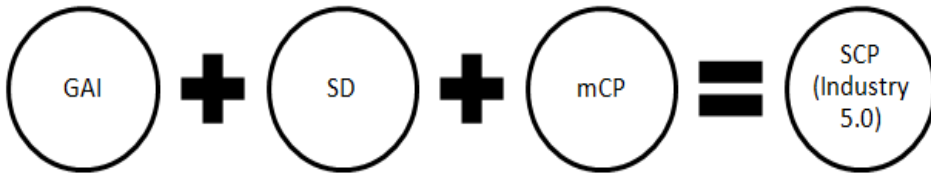
5. Result and Findings

Therefore, the use of SD enables GAI to expand CP beyond short-term adjustments and actions, empowering businesses to foresee and create content that takes into account projected future customer preferences and behaviours which seeks to solve the requirement of so-called sustainable consumption patterns by providing the answer in the form of customers mass customization which can be used by the companies to avoid red queen effect currently prevailing in their respective industries thus getting ahead in race of competition and preparing them for future industry 5.0.

6. Conclusion

In the future, companies should produce fewer products, try to design products with longer life cycles and apply circular economy principles. At the same time, customers who are aware of sustainable production and consumption look to the personalization of products to maintain an adequate level of quality of life with rational use of limited resources.

Figure 2. *Generative Artificial Intelligence, Smart Data and mass customer personalization put together will create sustainable consumption pattern for Industry 5.0.*



Note: *GAI – Generative Artificial Intelligence, SD – Smart Data, mCP – Mass customer personalization, SCP – Sustainable consumption pattern.*

Source: *Own study.*

Providing personalized products can guarantee benefits for both sides of the transaction. A customer who is satisfied with the product he or she receives will be more loyal, which in turn can translate into revenue stability for the manufacturer.

6.1 Limitations

The advent of GAI presents a set of issues pertaining to the security of data, the capacity to work together seamlessly, and the ethical implications that need to be taken into account.

6.2 Research Implication/ Future Scope of Work

The research conducted prompts further studies in the future to demonstrate the impact of personalized manufacturing on extending the life cycle of products, reducing overall consumption, and overall reduction of energy and natural resource consumption, especially in the context of the conscious purchasing decisions of today's consumers.

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