

A Novel Business Strategies Framework of Do-It-Yourself (DIY) Practises in Logistics to Minimize Environmental Waste and Improve Performance

Abstract: The transportation sector is consuming a high quantity of oil and producing air pollution, CO₂, allergies, as well as promoting the storage of goods in traditional warehouses. It's creating not only waste and polluted the environment but also increase the temperature, air pollution, and low rainfall. The present study intends to uncover and understand the challenges of logistic infrastructure as well as how the adoption of Do-It-Yourself (DIY) business strategies is useful to encourage those practices and technology which are useful in transforming the logistic infrastructure into an eco-friendly environment. The DIY focuses on purposely utilising digital technologies to increase the engagement and involvement of customers in businesses. Moreover, DIY enables organisations to produce products and services that are highly demanded and have high acceptability. After doing an extensive literature review the enablers of DIY are identified and empirical investigation has been conducted. The analysis of the study provides a business strategies framework of DIY which would help the logistics managers in the proper implementation of the Do-It-Yourself (DIY) practices to minimize negative environmental impact and improve business performance.

Keywords: Business Strategies, Environmental waste, Performance, Framework, Logistics, Industry 4.0 technologies

1. INTRODUCTION

The principal emphasis of Do-It-Yourself (DIY) is to establish a culture of participation so that groups, individuals and businesses develop product and services themselves (Chen and Wu, 2017). It is a science that is used to motivate and encourage groups, individuals and businesses to utilise techniques that help limit the misuse of resources (Mickley et al., 2019; Madldini, 2016; Cloutier et al., 2018; Ethirajan et al., 2021). The utilisation of DIY encourages the use of technology and practices that help create an optimal solution by involving all the stakeholders (Madldini, 2016; Cloutier et al., 2018; Hunka et al., 2021). Numerous recent studies have attempted to study the utilisation of DIY in public places, customer engagement, cinema practices, manufacturing, fashion industries, homes and innovation (Madldini, 2016; Chen and Wu, 2017; Cloutier et al., 2018; Ritz et al., 2019; Mickley, et al., 2019; Frei et al., 2020). Nevertheless, limited studies currently exist on the role of DIY in creating an eco-friendly logistical infrastructure.

It is important to note that the logistics industry is a significant component of business structure, societal welfare and economic development (Klumpp et al., 2013; Pellegrini et al., 2018). Thus, changes in the logistics industry have significant effects regarding the maintenance of societal and environmental welfare (e.g., low smoke and noise levels, improved air quality, optimal waste management and efficient utilisation of various natural resources) (Mickley et al., 2019; Klumpp et al., 2013; Li et al., 2021). Our research is based on the Kingdom of Saudi Arabia (KSA) a major consumer and producer of oil. We apply this context to understand the environmental challenges caused by the oil and transportation sectors, and the utility of DIY science in addressing this issue. This study investigates how DIY science can encourage technology and practices that help generate logistical infrastructures, which are environmentally friendly. In this research, we address the two research questions: (i) determine the issues and challenges facing the oil production and transportation logistical infrastructures in KSA. (ii) Investigate the concept of DIY, its applications and environmental implications of DIY concerning logistical infrastructural issues in KSA for oil production and transportation.

The rest of the paper is divided into seven sections. The first two sections are the introduction and interview of the paper. In section three, a review of relevant theories is given and methodology is section four. In section five, analysis and discussion are provided. Implications and conclusion are provided in sections six and seven.

2. LITERATURE REVIEW

Do-it-Yourself (DIY) represents the way of achieving goals without the help of professional service providers (Ng et al., 2020; You et al., 2020). This method is being adopted by individuals, groups, and organisations operating in different sectors, such as environmental protection, film, global changes, local markets, the music industry, private enterprises, classrooms, universities and publication libraries (Ramanathan et al., 2014; Cloutier et al., 2018; Ritz et al., 2019). Various researchers have presented different definitions and conceptualisations of DIY. The term is constantly evolving and is increasingly being utilised in different disciplines (Maldini, 2016; Mickley, et al. 2019). Cloutier et al. (2018) argued that DIY represents the philosophy of increasing public involvement to create the best solutions for the development of urban areas. Salamone et al. (2017) noted that DIY would be helpful for improving indoor environmental quality and overall quality of life. Ritz et al. (2019) observed that DIY gave rise to consumer culture and converted the traditional market into a digital market in areas such as the music industry, cinema, and the fashion industry.

2.1 Existing studies on DIY

Research shows many studies on DIY and cognate areas, Maldini (2016) described DIY as a broad range of activities that foster the involvement of existing and targeted users of products and services to increase their influence on producers to design products according to the wants, needs, and demands of customers. Moreover, researchers argue that DIY represents the design and creation of things to create a better future (Maldini 2016; Smith et al., 2019). Mickley et al. (2019) believe that DIY does not promote the culture of complaints regarding the environment; however, it is a means of finding solutions to reduce the negative effects of global environmental changes.

DIY was introduced in North America to control extreme behaviour in societies and patents (Ferretti, 2019). Moreover, researchers have argued that there exists strong evidence of the usage of DIY to create tools for construction and repair of the home and other items (Ferretti, 2019). The initial focus of DIY was to create an environment where products and developed are developed as a result of individuals in society doing tasks themselves (Chen and Wu, 2017). Another study highlighted that as a result of DIY, a culture of providing error-free goods and services on the first attempt was created (Duncombe, 1997). Resultantly, it may be argued that DIY is increasingly becoming a science for creating and integrating technologies and best practices that can minimise the waste of environmental, financial and organisational resources (Ramanathan et al., 2014; Ritz et al., 2019).

2.2 DIY Applications

There are different applications of DIY, which have caused positive changes in homes, public places, innovation, supply chain management, customer engagement, manufacturers, cinema practices, fashion and processes of converting raw material into finished items. DIY has also increased people's indoor quality of life. Different industries are applying DIY differently. For example, researchers have argued that DIY has been helpful for creating optimal designs for both public places and homes so that the public infrastructure and people's comfort levels are enhanced (Salamone et al., 2017; Cloutier et al., 2018). Ramanathan (et al., 2014) observed that as a result of DIY, the culture of pushing goods has changed to a concept of pulling (Push and Pull) demands whereby manufacturers are improving the supply chain management process and are enjoying competitive advantages in modern times. Ritz et al. (2019) believed that the quality of products in the fashion industry have improved, as has picture quality in the cinema industry with the use of DIY technology. Maldini (2016) noted that DIY changed the

local market by fostering local production culture. This has reduced the cost of the design and production of goods, allowing organisations to profit. Poppendieck et al. (2019) observed that due to DIY, ventilation guidelines have improved, which in turn have improved quality of life. It is imperative to recognise the impact of DIY on the environment. Here, we review selected studies, which highlight the environmental implications of DIY, such as noise pollution, air quality, climate change, land use, waste management and biodiversity.

DIY has helped reduce transportation costs and has improved the distribution of resources, thereby reducing waste and air pollution (Maldini, 2016; Ramanathan et al., 2014). DIY has also promoted the culture of involving customers in technology, which has enhanced the concept of personalisation and brought flexibility in the use of technology (Hatton-Jones, et al., 2015; Ferretti, 2019; Baloch et al., 2021). In many cities across the globe, DIY laboratories are emerging (Hecker et al., 2018; Landrain, 2013). These are structured on the principles of open-source system. These DIY laboratories are independent society-based research centres, often established by scientists and science enthusiasts to experiment, learn and set foot into the science, technology and innovation (STI) advancement world. Such ‘citizen laboratories’ are booming; drawing in communities, venture capitalists, groups and volunteers. They are becoming substitute homes for skill within and beyond the theoretical limits of universities eager to spread the procedures of technology, innovation and science; to general society (Landrain, 2013; Sleator, 2016; Hecker et al., 2018; Baloch et al., 2021).

In conducting basic and advanced experiments in private structures often known as ‘hackspaces’, these DIY labs not only challenge the monopolisation of research institutes and traditional universities as the basic centres of practising science (Downes et al., 2013; Halfacree, 2004). They also give individuals an opportunity to meet at unusual locations, such as private homes (Meyer, 2013), coffee shops, pubs (Secord, 1996) and museums (Ellis & Waterton 2005) to share potential methods of boosting scientific measures and developing technology. These DIY labs provide tools and scientific education to people who show a willingness to learn. DIY labs are a platform for scientific innovation at the grassroots level. DIY labs promise to democratise and demystify STI by empowering amateurs to carry out complex experiments (Sleator, 2016; Meyer, 2013) and encourage citizen science in fields such as bioinformatics, molecular biology and DNA recombinant technologies and their sub-fields, such as gene editing (e.g., Cas9/CRISPR) technologies and genetic engineering.

2.3 DIY Operation

Universities are places for complex research and provide opportunities for further identification and research chances for innovation (Seyfried et al., 2014), however, concerns are emerging regarding the regulation and operation of DIY labs (Ferretti, 2019; Wolinsky, 2005), their key implications (Fiske et al., 2019; Wrexler, 2016), and internal conflicts and the risks posed by these labs while the inner conflicts of their risks encouraging responsible science (Tanenbaum et al., 2013). These laboratories can also pose a threat to environmental safety and public health as they are free from the regulations and rules that govern the activities of well-established organisations (Gorman, 2011; Unterfrauner et al., 2019). Their semi-regulated experiments, held in mostly under-developed facilities (including garages and kitchens), which regularly break the protocols of international laboratories (as contended by Revill and Jefferson [2013]), might intentionally or accidentally have devastating effects on human health and safety. The majority of DIY ownership structures and the open-source principles on which they operate, further exhibit potential difficulties for the administration of patent rights and intellectual property within the boundaries of technology and science strategy regimes.

Existing literature on DIY applications has focused on civic initiatives and climate change (Cloutier et al., 2018), minimising the negative impact of global changes (Mickley, et al. 2019). It also enhances the quality of the indoor environment through effective ventilation (Poppendieck et al., 2019), promoting the culture of local production and local employability (Maldini, 2016), and increasing personalisation to know customer choices and demand (Hatton-Jones et al., 2015; Ferretti, 2019). However, there is no significant literature about how DIY can have a positive effect on the environment particularly from logistical perspectives in KSA. Ramanathan et al. (2014) looked at the impact of DIY on supply chain management, but they failed to provide evidence about utilising the support for quantitative and qualitative research data. Moreover, their explanation is not supported by literature, as limited literature exists on the topic, particularly from the perspective of the environmental implications of DIY on logistics in KSA.

Most existing research integrates DIY with the technology acceptance model (Helia et al., 2018). Such studies have been conducted in various industries, including the core banking systems, information systems (Helia et al., 2018), and wearable electronics (Helia et al., 2018). However, there is no research about the environmental effects of DIY on logistics in KSA. KSA is an oil-producing country, and oil production has affected biodiversity, air quality and waste, particularly with respect to logistics. This study aims to bring awareness by developing a conceptual framework for addressing the environmental challenges related to logistics by utilising the DIY concept. The study also seeks to develop a model of logistics that can improve

mass production at a local level as well as reduce transportation, thus improving the quality of the roads, improving air quality, reducing warehouse costs, reducing waste, and improving quality of life. Different theories can be utilised to build the conceptual model, including the technology adoption model (TAM), social influence theory, and united theory of acceptance and use of technology. These theories will help determine the use of technology and resource management to improve logistics by utilising the concept of DIY in KSA.

3. RELEVANT THEORIES AND REVIEW

As discussed above, DIY has been merged through new web technology; therefore, there is a need for it through the adoption of IT and innovation in the DIY approach concerning the environmental effect of logistics in KSA. It is necessary to consider the adoption of technology from the individual's perspective and simultaneously explore the organisational context of the adoption of an innovative DIY approach in business, to reduce the environmental impact of DIY in logistics. According to Venkatesh and Davis' (1996) TAM model, as shown in figure 1, there are external factors, perceived uses of technology and perceived ease of use, all of which lead to the final behavioural intention of the individual. Finally, behavioural intentions lead to the actual use of the technology.

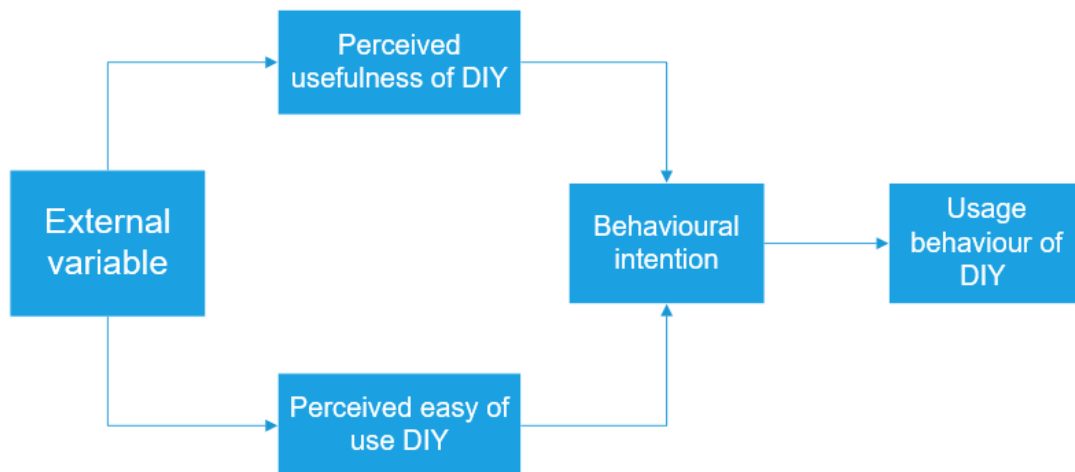


Figure 1: TAM model (Venkatesh and Davis, 1996)

Diffusion of Innovation (DOI) theory as shown in figure 2 can also be used to explore the organisational context concerning the adoption of an innovative DIY approach concerning the impact of logistics on the environment. According to Rogers (1995), the individual leadership of an organisation, the external characteristics of an organisation fascilitate innovation. At the same time, the internal organisational structure also affects the adoption of innovation within

an organisation. As this research is exploring DIY in the context of the effect of logistics on the environment on one of the selected organisations of KSA, this theory would be useful in exploring the local organisational context.

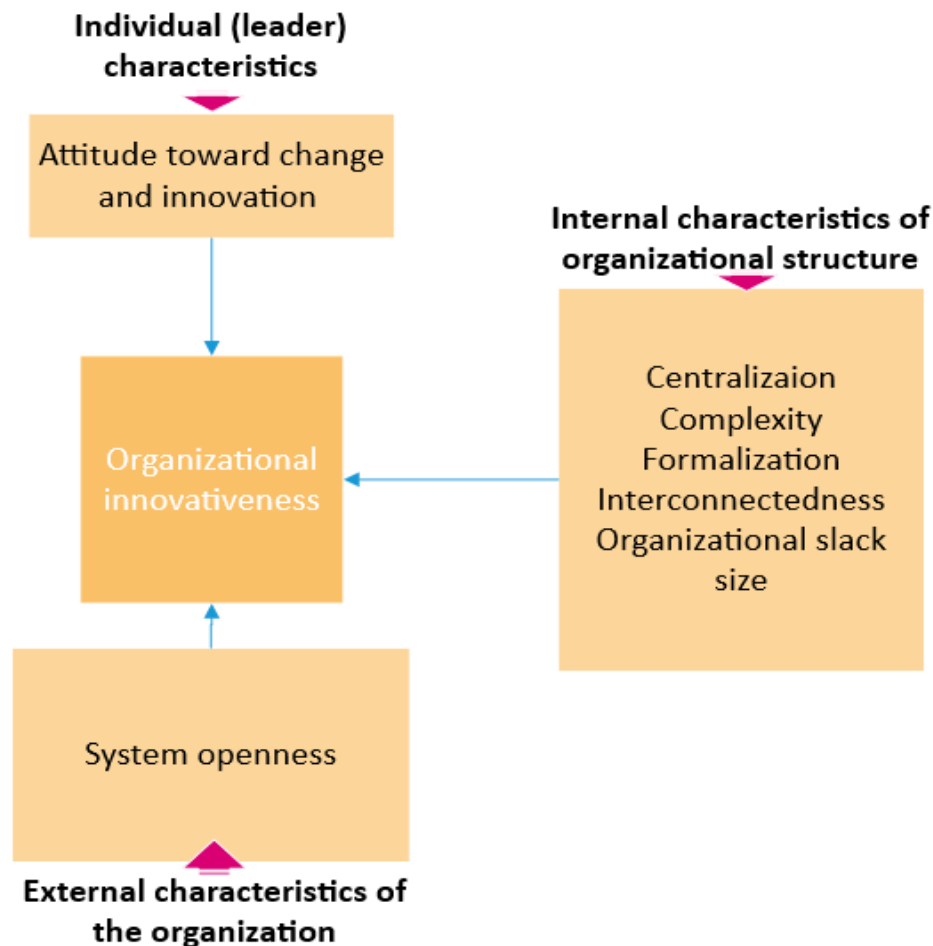


Figure 2: DOI theory (Rogers, 1995)

The final theoretical framework of this paper is based on both the TAM and DOI theories. It can help explore both individual and organisational contexts on the impact of DIY in logistics on the environment. Figure 3 shows the overall theoretical framework of this research.

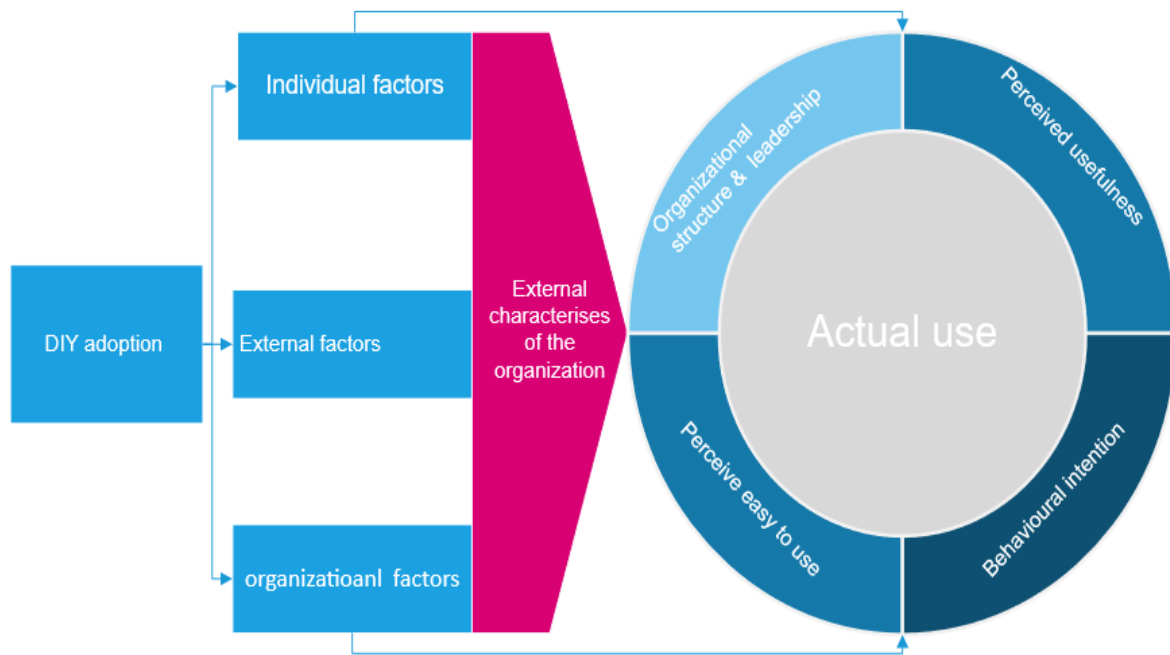


Figure 3: Theoretical framework (developed for this research)

4. RESEARCH METHODOLOGY

An inductive research approach is being used for this research because research is developing a DIY research framework in the context of the supply chain environment. Therefore, this inductive approach emphasis on exploring existing research phenomenon from a new DIY perspective or investigate a new supply chain environment impact phenomenon whereas deductive approach focusses on causality.

Qualitative semi-structured interviews are one of the most dominant and widely used methods of data collection within the social sciences (Bradford & Cullin, 2012). Interviewing supply chain actors who work with supply chain operations gives knowledge on their approach towards supply chain performance.

Semi-structured interviews were conducted with eight management-level participants of the Mohammed Bawazir for Trading Co Ltd company (MBT) of Saudi Arabia (mbtksa.com, 2019).

Table 1: Demographic Features of Participants

No	Gender	Age Group	Designation	Education	Experience
R1	Male	24	Operations manager	Postgraduate	10 years

R2	Male	36	Executive director	Postgraduate	18 years
R3	Male	39	Staff	Undergraduate	7 years
R4	Male	41	Staff	Undergraduate	6 years
R5	Male	43	Government officer	Graduate	12 years
R6	Male	45	Government officer	Postgraduate	14 years

The researcher reached out to ten people from a transportation company, the ministry of environment, and the ministry of transportation in KSA. However, only six people agreed to provide data for this study-four officer and staff members of a transportation company, one officer from the ministry of environment and one from the ministry of transportation. The prominent demographic features of the six respondents are given in Table 1.

5. ANALYSIS AND DISCUSSION

This study collected data from principal authorities in the government and the logistics department through the semi-structured interview method. Interviews were conducted and recorded with the consent of the participants. Different studies described the significance of thematic data analysis as it provides support to extract repeated ideas, common words, and common patterns (Creswell, et al. 2007; Creswell & Miller, 2000). Thematic data analysis was used to determine the main themes, keywords and initial codes. There are 2 themes, 6 codes and nearly 86 keywords for extracting the results related to the objectives of the research. Table 2 and Table 3 provide details about the main themes, codes and keywords.

5.1 Government Policies: Logistical issues

Main theme 1: Existing logistical issues

Definition: Current organisational practices to arrange goods from raw material to final products up to the end to customers

Table 2: Main codes and keywords

Codes	Keywords
Government policies	Government control Lack of environmental policies Customs duties Limited ISO practices Dictates operational policy

	High consumption of oil High CO ₂ More air pollution Asthma disease Water scarcity Risks for climate changes Improper logistics planning Lower SCM courses Policies for green logistics Lack of investment
Logistics system	Lack of professionalism Traditional warehouses High storage costs Limited local production More stock inventories High use of natural resources Improper waste management Traditional procurement Limited knowledge Limited e-commerce technologies High load More wear and tear Limited recycling practices Low level of best practices Low customer engagement Push product strategy

5.2 Government Policies

It is imperative to understand how the policies of the government of KSA influence the existing logistical infrastructure.

Respondent 1 stated that ‘in some companies of the transportation and other sectors, the focus is limited for bringing the best infrastructure of logistics which can preserve the environment.

Respondent 4 stated that ‘our country is oil and gas-rich resources; therefore, it is a profitable business to transport goods from far away locations’.

At present, KSA is regarded as the highest producer of oil, and the Saudi government is offering oil supply at cheaper rates on the international market; therefore, several transportation companies have been established in KSA. Many transportation companies have long routes that move goods from seaports to final consumers. Due to oil consumption, there has been an increase in carbon dioxide and air pollution.

Respondent 2 said ‘still, we are unaware about the government’s policy for transforming the logistics business in the best interest of human health and environment’.

Respondent 1 states that KSA has ‘...Vision 2030 with respect to [increasing] investment in *those* technologies and practices [that] can create [an] environmentally friendly infrastructure in Saudi Arabia’.

Respondent 2 said, ‘although in developed countries educational courses are created for green production, logistics, and environment, [the] Saudi government recently shifted focus on the education sector as part of Vision 2030 with respect to [the creation of a] green [logistical] infrastructure’.

Respondent 5 said, ‘although we are taking friendly initiatives to protect [the] environment, [we] are still using heavy containers [that] are causing wear and tear [on] the road and are also increasing noise pollution’. This shows that the Saudi government must further tighten the load management policy to save their roads and improve the air quality.

It has been observed that due to the logistical infrastructure not being sufficiently advanced and recent attention given to logistical policies, challenges for the Saudi government have increased, and because of this, the government cannot fully implement ISO practices, particularly in the transportation sector. *Respondent 6* said, ‘[the] water price is more than [the] oil price in KSA due to limited water resources.

Higher oil consumption is linked directly with climate change (i.e., high temperatures), particularly when KSA is facing the problems of water scarcity throughout the country. Therefore, the Saudi government must establish policies that help the country to meet the vision of 2030 concerning the development of green transportation as well as logistical infrastructure.

5.3 The Logistical System

Manufacturing companies in KSA are still following a ‘push’ strategy, which means that there is no strong connection between manufacturers and consumers; therefore, manufacturers are unable to identify the precise demands of consumers. *Respondent 3* said, ‘we import [a] the higher quantity of consumer goods from other countries and store them in warehouses. These goods are not produced locally; therefore, the [costs] of transportation and warehousing are high’. It has been observed that many consumer products are not produced locally; therefore, the costs of storage and transport are higher in the KSA than in other countries. *Respondent 1* said, ‘although our transportation company is making a profit, [we] are still utilising traditional

processes of procurement, [we still] have [an] old [warehouse] structure and limited knowledge about [waste management]’. The findings of this study show that even though the respondents are aware of the best logistical practices, the government and company owners are not fulfilling their responsibility to preserve natural resources and quality of life.

Even though multinational companies are connected closely with customers through e-commerce technology, which helps identify the precise demands of the consumers, some Saudi companies are still not fully adopting the best practices. *Respondent 2* said, ‘our knowledge is limited about the advantages of green logistics. Therefore, usage of natural resources is higher, which is affecting the environment of our country. For example, we still place orders for importing foreign goods, which has increased the number of transportation companies and has also increased the cost of transportation and wear and tear of roads. It has also increased the cost of warehousing’. It has been found that to decrease transportation and warehousing costs, it is important to utilise green logistics and e-commerce technologies.

5.4. Advanced Business Technology

Main theme 2: Best technological practices

Definition: Current best technology use in logistics

Table 3: Main codes and keywords

Codes	Keywords
Advance business technology	Green supply chain Autonomous vehicles Transportation environmental management Environmental microcontroller units Green procurement system Brick and click business Eco-friendly warehouse design Circular material use Load optimisation Best modes and energy use Energy-efficient technology Smart apps Value-added services
Green production	Industry 4.0 technologies Pollution prevention Eco-friendly technology Eco-innovation Natural capital Remanufacture Renewable resources Increase recycling activities

	Environmental awareness Environmental legislation Selection of suppliers Waste treatment/reuse Energy optimisation Inventory optimisation Low carbon emissions ISO standards Local production Just-in-time production Processes improvement Green products Instruction for customers
Green logistics	Cloud logistics Reverse logistics Zero waste Demand-responsive system Optimisation of resources Eco-friendly packaging Waste management Indoor environmental quality Sustainable transportation Optimisation of warehousing Optimisation of distribution systems Just-in-time inventory Eco-friendly logistics
Media and engagement	E-marketing Educating consumers Product design Digital marketing Trends and fashion Preferability Green packaging Social media marketing Publicity and education Target market

Green supply chain management is popular in DIY practices, as it focuses on resolving environmental problems. *Respondent 6* said, ‘the government established the Saudi Energy Efficiency Centre for meeting Vision 2030 in the country. The idea underlying the establishment of this centre is introducing energy-efficient technology as well as best usages and modes of energy. The country [aims to introduce] DIY electric vehicles for decreasing the dependency on oil and [for converting] traditional logistics into green logistics’. It has also been observed that the focus of the Saudi government is on an environmental transportation management system in line with Vision 2030. By utilising environmental transportation

management practices, organisations have become responsible for adopting DIY techniques and practices that can minimise the negative impact on the environment and increase the efficiency of operations. The current logistical infrastructure is not environmentally friendly, but the government is taking steps in that direction according to its Vision 2030. The Vision 2030 programme is focused on investing in green supply chain management practices.

Respondent 4 said, ‘our company has recently imported autonomous vehicles and constructed eco-friendly [warehouses] for fulfilling their social responsibility toward the environment and to create a positive difference [for] its customers’. At present, few companies are fulfilling their environmental responsibility by investing in DIY techniques and technologies. Their investment is contributing to environmental transportation management. Companies have also invested in digital technologies so that they can understand the expectations of their customers, their tastes, behaviours and demands so that they can make supply decisions accordingly.

Respondent 1 said ‘our company invested in digital applications for identifying the demands of the customers and also to become more approachable and accessible for the customers’. DIY has given rise to a ‘make’ culture, which has increased the use of digital media to provide value-added services to all its customers. By using such digital apps, customer involvement in the design and production processes has increased, as the manufacturers are able to design products and services according to the expectations and preferences of the customers.

5.5 Green Production

Respondent 4 said, ‘our company [has invested] in [improving] production processes and renewable sources. For example, our company invested [in] generating electricity from solar, wind and municipal waste [sources]. It will minimise the usage of those manufacturing technologies [for] which consistent electric supply is required. Thus, the focus of our company is on installing industry 4.0 technologies, which are [environmentally friendly] and protect [the] environment from pollution’. At present, the focus of some Saudi organisations has been on the usage of industry 4.0 technologies. These consume fewer resources and are environmentally friendly. Such technologies help design green products and create the best recycling activities. *Respondent 6* said, ‘at present, the Saudi government is working on environmental legislation to ensure that such technologies are installed and used by the organisations that are [strictly following] ISO practices and ensure that [energy optimisation] takes place and there is [less] air pollution’.

The Saudi government is specifically focusing on transportation and manufacturing companies. The current legislation is specifically targeting these companies to increase their usage of smart logistics and environmentally friendly manufacturing technologies. Respondent 4 said, ‘we arranged different meetings for finalising the roadmap to ensure that we import only the right set of smart manufacturing technologies, which can prepare [the best product design] and also provide information to customers about product usage and save packaging to reduce waste’. Thus, smart technologies can enhance green supply chain management practices in Saudi Arabia.

5.6 Green Logistics

The concept of DIY has increased practices and methods that foster green supply chain management. *Respondent 4* said, ‘our company recently purchased [a] few cloud logistic [software packages] and electric vehicles for testing the effectiveness and efficiency of smart technologies in our business. Our company also created the strategy of making [a] [reasonably sized] box to reduce waste. Our company also designed the containers and boxes in such a way that [they provide] just the room that is needed’.

Cloud logistics have become popular, as they engage all stakeholders on a single platform and offer real-time communication. The usage of DIY techniques (e.g., reverse logistics, cloud logistics) has increased the best use of resources, as its focus is on the culture of zero waste. DIY represents designing and creating things for the possibility of a better future. By utilising DIY techniques (e.g., reverse logistics), manufacturing companies can reuse, recycle, resell and refurbish consumer goods that consumers return. The companies are creating a system of supply and demand so that warehouse optimisation can be brought about through a just-in-time (JIT) inventory.

Respondent 6 said, ‘now the Saudi transportation companies are enhancing the safety of products to minimise the impact on quality of life, as such transports operate in social communities. Moreover, Saudi manufacturing companies have started to invest in digital applications to ensure that real-time information from consumers is collected and products or services are designed accordingly. This is also being done so that products are designed according to exactly what the consumers want so that they don’t have to return the products. This would help reduce the transportation cost when products are returned’. It has been observed that Saudi companies are utilising a ‘pull’ strategy to engage customers with manufacturers and to design products according to the needs of the customers. DIY

technologies are increasing customer involvement and keeping records of the demands of the customers.

5.7 Media and Engagement

The usage of e-marketing is widely recognised nowadays, as it involves DIY practices that can engage the customers in utilising social media technologies. *Respondent 3* said, ‘we invested huge funds in e-marketing, as it can capture the [tastes] and experiences of the customers, which are helpful for modifying and improving the quality of products and services. It has been found that digital marketing and e-marketing are widely utilised for engaging customers so that goods can be created by manufacturers for the targeted delivery of goods and storage of goods at the minimum possible cost. Moreover, such technologies help educate consumers about the need to reduce packaging costs and to resell their goods.

Respondent 4 said, ‘our company is researching green packaging so that such packaging can be created, which only involves minimum efforts and minimum use of natural resources. It can be regarded as [environmentally] friendly or sustainable packaging, and we are creating mass awareness in this regard so that our customers are aware of how the manufacturer is preserving natural resources and meeting their social responsibility’. Green packaging may be regarded as a DIY technique because it does not promote waste, and as such, it is environmentally friendly. Therefore, green packaging is regarded as the best solution for creating products from the resources available.

6. IMPLICATIONS

This study has been conducted to explore the existing issues in the logistical infrastructure of KSA. This study has investigated and understood the issues in the logistical infrastructure. It has discussed DIY in the context of its environmental implications on the logistical infrastructure of KSA. Social constructionism remains the research approach of this study, the aim of which has been to collect the experiences of all stakeholders belonging to the logistics sector in KSA. This study used semi-structured interviews to collect research data from logistics stakeholders. Moreover, this study used thematic analysis and extracted two major themes, eight keywords and six codes. It is of high importance to first understand the strengths and weaknesses of Saudi Arabian logistical infrastructure. As KSA is the world’s largest oil-producing state, the Saudi government supplies oil to the logistics sector at very low prices. Secondly, a significant portion of the population is rich and depends heavily upon imported products. This is the major reason there are a large number of transportation companies and

international manufacturers in KSA – because it is a highly profitable business. These international manufacturers have hundreds of warehouses and transportation vehicles that directly or indirectly influence the environmental factors in KSA.

Study findings show that the current logistical infrastructure of KSA has been facing various challenges concerning the logistical system and government policies. As a part of Saudi Arabia's Vision 2030, the country has shifted its focus to transforming the whole logistical infrastructure through the introduction of eco-friendly technology and practices. This study's findings also show that the Saudi government and educational institutions have to urgently invest in educational resources that can increase awareness of renewable resources and logistical infrastructure.

Moreover, heavy traffic results in high consumption of gas and oil, which in turn increases the level of noise and air pollution. The Saudi government has developed significant energy usage and logistics plans that will be fully implemented by 2030. The traditional practices that are commonly used in the Saudi logistics sector have many problems, such as poor customer management and waste management. Moreover, the implementation of push product strategies is very common among KSA manufacturers. Resultantly, these manufacturers have to store consumer goods locally and thus require many warehouses and huge amounts of natural resources. According to the extant literature, DIY mainly aims to develop and design practices and technologies that may create better future opportunities (Maldini, 2016; Mickley et al., 2019; Ritz et al., 2019). The leading companies using the DIY culture emphasise investment in digital technologies to better understand the demand and expectations of customers. These initiatives also help make decisions such as JIT inventory, quantity of goods to be produced and stored locally and usage of transportation.

Study findings show that the purpose behind the establishment of the 'Saudi energy efficiency centre' by the Saudi government is to introduce environmentally friendly technologies and reusable energy resources (Blazquez et al., 2017; Salam and Khan, 2017). Moreover, this energy centre aims to find out energy sources that are more efficient, such as municipal waste, wind and solar systems as well as to introduce electric vehicles with the ability to reduce many serious problems in the logistical infrastructure (Griffiths, 2017). Recent studies have highlighted that DIY primarily emphasises creating and integrating practices and technologies that minimise the waste of organisational, financial and environmental resources (Ramanathan et al. 2014; Ritz et al., 2019). According to this study's findings, green supply chain management practices (e.g., green procurement, green production, environmentally friendly

practices and electric vehicles) can use natural, financial, organisational and operational resources in the best possible manner.

This study suggested the participants take on an environmental transportation management system through which the negative utilisation of natural resources can be reduced and organisations' operational efficiency can be improved. DIY is the science that focuses on purposely utilising digital technologies to increase customers' engagement and involvement in businesses. Moreover, DIY enables organisations to produce products and services that are in high demand and have high acceptability. Additionally, e-marketing and digital technologies have brought customers together at a single platform and enabled businesses to create a positive image and reputation by showing that they are fulfilling their responsibilities toward the social environment.

7. CONCLUSION AND FUTURE RESEARCH DIRECTIONS

The prime objective of this article is to identify elements of the logistics sector that negatively influence the natural environment in the context of KSA. It has been observed that the Saudi government has recently shifted its focus to the development of environmentally friendly logistical infrastructure and government policies but require a significant amount of time to completely transform the logistical infrastructure. Results show the extensive usage of heavy containers; gas and oil; no-load optimisation; high air and noise pollution; wear and tear of roads; limited awareness about techniques regarding waste management; and typical warehouse design. Thus, using DIY science is crucial, as it promotes practices and technologies that help preserve natural resources and the environment. Examples of these practices and technologies include cloud logistics; industry 4.0 technologies; green packaging; green e-procurement; environmental microcontroller plants; reverse logistics; transportation management systems; electric vehicles; e-marketing; digital apps and tools; and renewable resources. These practices and technologies not only can transform the logistics industry but can also address environmental issues such as land optimisation; waste; temperature; smoke; and air and noise pollution. Additionally, these practices and technologies use fewer natural resources (e.g., land, gas, oil and trees) compared to traditional practices and technologies and provide value-added services to their customers.

7.1 Unique contributions and recommendations

- It is recommended that the Saudi government should immediately increase its investment in environmental policies and practices that focus on adopting DIY science to preserve natural resources.
- It is suggested that internal stakeholders and manufacturers should remain in touch with customers to know their demands, tastes, trends, preferences, and behaviours. Through customer engagement, they can minimise delivery and production losses as well as stock inventories.
- Transportation companies should produce or import electric vehicles for which less gas and oil is required. Resultantly, it would help reduce air pollution and reduce the prevalence of asthma.
- Creating load optimisation policies is crucial for reducing oil consumption as well as wear and tear of roads by heavy containers.
- It is important for the Saudi government to promote the usage of and to highly invest in renewable resources and generate energy from wind, solar and waste sources. Moreover, the Saudi government should create an immediate plan to produce electricity to facilitate the usage of environmentally friendly autonomous vehicles as part of its Vision 2030.

References

- Arab News (2019). *Plantation of Trees for Vision 2030* [online] <https://www.arabnews.com/node/1572346/saudi-arabia> (Accessed 22 October 2019)
- Baloch, M. A., Ozturk, I., Bekun, F. V., & Khan, D. (2021). Modeling the dynamic linkage between financial development, energy innovation, and environmental quality: Does globalization matter?. *Business Strategy and the Environment*, 30(1), 176-184.
- Blazquez, J., Hunt, LC, Manzano, B (2017) Oil subsidies and renewable energy in Saudi Arabia: A general equilibrium approach. *The Energy Journal* 38: 1–17.
- Bradford, S., & Cullen, F. (2012). *Research and research methods for youth practitioners*. London: Routledge
- Chen, Y. & Wu, C. (2017). The Hot Spot Transformation in the Research Evolution of Maker. *Scientometrics*, 113(3), 1307-1324.
- Cloutier, G., Papin, M., & Bizier, C. (2018). Do-It-Yourself (DIY) Adaptation: Civic Initiatives as Drivers to Address Climate Change at the Urban Scale. *Cities*, 74, 284-291.
- Crowther, D. & Lancaster, G. (2012). *Research Methods* (2nd ed.). Hoboken: Taylor and Francis.
- Creswell, J., Hanson, W., Plano, V., and Morales, A. (2007). Qualitative Research Designs: Selection and Implementation. *The Counseling Psychologist*, v 35 (2), pp. 236-264.
- Creswell, J., and Miller, S. (2000). Determining Validity in Qualitative Inquiry. *Theory Into Practice*, v 39 (3), pp 124-130.
- Davis, F. D. & V. Venkatesh. (1996). A Critical Assessment of Potential Measurement Biases in the Technology Acceptance Model: Three experiments. *Internat. J. Human-Comput. Stud.* 45, 19-45.
- Donley, A. M. (2012). *Research Methods*. New York: Infobase Publishing.
- Downes, J., Breeze, M. & Griffin, N. (2013). Researching DIY Cultures: Towards a Situated Ethical Practice for Activist-Academia. *Graduate Journal of Social Science* 10(3), 100-124.

- Duncombe, S. R. (1997). Notes from the Underground: Zines and the Politics of Underground Culture. Microcosm Publishing.
- Ellis, R. & Waterton, C. (2005). Caught Between the Cartographic and the Ethnographic Imagination: The Whereabouts of Amateurs, Professionals, and Nature in Knowing Biodiversity. *Environment and Planning D: Society and Space* 23(5), 673-693.
- Ember, C. R. & Ember, M. (2009). Cross-Cultural Research Methods (2nd ed.). Lanham: Altamira Press.
- Ethirajan, M., Arasu M, T., Kandasamy, J., KEK, V., Nadeem, S. P., & Kumar, A. (2021). Analysing the risks of adopting circular economy initiatives in manufacturing supply chains. *Business Strategy and the Environment*, 30(1), 204-236.
- Ferretti, F. (2019). Mapping Do-It-Yourself Science. *Life Sciences, Society and Policy* 15(1), 1-23.
- Fiske A., Del Savio L., Prainsack B. & Buyx A. (2019) Conceptual and Ethical Considerations for Citizen Science in Biomedicine. In: Heyen N., Dickel S. and Bruninghaus A. (eds) Personal Health Science. Springer VS, Wiesbaden.
- Frei, R., Jack, L., & Krzyzaniak, S. A. (2020). Sustainable reverse supply chains and circular economy in multichannel retail returns. *Business Strategy and the Environment*, 29(5), 1925-1940.
- Gomm, R. (2008). Social Research Methodology: A Critical Introduction (2nd ed.). Basingstoke: Palgrave Macmillan.
- Gorman, B. (2011). Patent Office as Biosecurity Gatekeeper: Fostering Responsible Science and Building Public Trust in DIY Science. *Marshall Review of Intellectual Property Law* 3(10), 423-449.
- Griffiths, S (2017) A review and assessment of energy policy in the Middle East and North Africa region. *Energy Policy* 102: 249–269.
- Halfacree, K. (2004) I Could Only Do Wrong: Academic Research and DIY Culture. *Radical Theory/Critical Praxis*, 68-78.
- Hammond, M. & Wellington, J. J. (2013). Research Methods: The Key Concepts. London: Routledge.
- Hatton-Jones, S. & Teah, M. (2015). Case Analysis of the Do-It-Yourself Industry. *Asia Pacific Journal of Marketing and Logistics* 27(5), 826-838.
- Hecker, S., Haklay, M., Bowser, A., Makuch, Z., Vogel, J. & Bonn, A. (2018). Innovation in Open Science, Society and Policy-Setting the Agenda for Citizen Science. Innovation in Open Science, Society and Policy; UCL Press: London, UK.
- Helia, V. N., Asri, V. I., Kusriani, E., & Miranda, S. (2018). Modified Technology Acceptance Model for Hospital Information System Evaluation – A Case Study. MATEC Web of Conferences (EDP Sciences) 154, 01101.
- Hunka, A. D., Linder, M., & Habibi, S. (2021). Determinants of consumer demand for circular economy products. A case for reuse and remanufacturing for sustainable development. *Business Strategy and the Environment*, 30(1), 535-550.
- Klumpp, M., Clausen, U., & ten Hompel, M. (2013). Logistics Research and the Logistics World of 2050. In Efficiency and Logistics, Springer, Berlin, Heidelberg, 1-6.
- Kumar, R. (2011). Research Methodology: A Step-by-Step Guide for Beginners (3rd ed.). London: SAGE Publications.
- Landrain, T., Meyer, M., Perez, A.M. & Sussan, R. (2013) Do-It-Yourself Biology: Challenges and Promises for an Open Science and Technology Movement. *Systems and Synthetic Biology* 7(3), 115-126.
- Lapan, S. D., Quartaroli, M. T. & Riemer, F. J. (2011). Qualitative Research: An Introduction to Methods and Designs. Hoboken: Wiley.
- Li, G., Lu, S., Shao, S., Yang, L., & Zhang, K. (2021). Do environmental regulations hamper small enterprises' market entry? Evidence from China. *Business Strategy and the Environment*, 30(1), 252-266.
- Lowndes, S. (2016). The DIY Movement in Art, Music and Publishing: Subjugated Knowledges. Routledge.
- Maldini, I. (2016). Attachment, Durability and the Environmental Impact of Digital DIY. *The Design Journal* 19(1), 141-157.
- Mbtksa.com. (2019). MBT – Mohammed Bawazir for Trading Co. Ltd. [online]<https://www.mbtksa.com/> [Accessed 31 October 2019].

- McNeill, P., Chapman, S. & MyiLibrary. (2005). *Research Methods* (3rd ed.). London, New York: Routledge.
- Meyer, M. (2013). Domesticating and Democratizing Science: A Geography of Do-It-Yourself Biology. *Journal of Material Culture* 18(2), 117-134.
- Mickley, J. G., Moore, T. E., Schlichting, C. D., DeRobertis, A., Pfisterer, E. N. & Bagchi, R. (2019). Measuring Microenvironments for Global Change: DIY Environmental Microcontroller Units (EMUs). *Methods in Ecology and Evolution* 10(4), 578-584.
- Ng, W., Arndt, F., and Huang, T. (2020). Do-It-yourself laboratories as integration-based ecosystems. *Technological Forecasting and Social Change*, 159, pp. 1-14.
- Pellegrini, C., Rizzi, F., & Frey, M. (2018). The role of sustainable human resource practices in influencing employee behavior for corporate sustainability. *Business Strategy and the Environment*, 27(8), 1221-1232.
- Pickering, M. & Griffin, G. (2008). *Research Methods for Cultural Studies*. Edinburgh: Edinburgh University Press. doi:10.3366/j.ctt1g0b2nv
- Poppendieck, D., Gong, M., Ng, L., Dougherty, B., Pham, V. & Zimmerman, S. M. (2019). Applicability of Spray Polyurethane Foam Ventilation Guidelines for Do-It-Yourself Application Events. *Building and Environment*, 157, 227-234.
- Quinlan, C. & Zikmund, W. G. (2015). *Business Research Methods*. Andover: Cengage Learning.
- Quinlan, C., Babin, B. J., Carr, J. C., Griffin, M. & Zikmund, W. G. (2019). *Business Research Methods* (2nd ed.). Andover: Cengage Learning.
- Ramanathan, U., Bentley, Y. & Pang, G. (2014). The Role of Collaboration in the UK Green Supply Chains: An Exploratory Study of the Perspectives of Suppliers, Logistics and Retailers. *Journal of Cleaner Production*, 70, 231-241.
- Revill, J. & Jefferson, C. (2013) Tacit knowledge and the Biological Weapons Regime. *Science and Public Policy* 41(5), 597-610.
- Ritz, W., Wolf, M. & McQuitty, S. (2019). Digital Marketing Adoption and Success for Small Businesses: The Application of the Do-It-Yourself and Technology Acceptance Models. *Journal of Research in Interactive Marketing*, 13(2), 179-203
- Rogers, E. M. (1995) *Diffusion of Innovations* (4th ed.). New York: Free Press.
- Salamone, F., Belussi, L., Danza, L., Ghellere, M. & Meroni, I. (2017). How to Control the Indoor Environmental Quality Through the Use of the Do-It-Yourself Approach and New Pervasive Technologies. *Energy Procedia* 140, 351-360.
- Salam, M.A., and Khan, S. A. 2017. Transition towards sustainable energy production – A review of the progress for solar energy in Saudi Arabia. *Energy Exploration & Exploitation*, vol 36 (1), pp 3-27.
- Saunders, M., Lewis, P. & Thornhill, A. (2012). *Research Methods for Business Students* (6th ed.). Harlow: Pearson.
- Saunders, M., Lewis, P. & Thornhill, A. (2016). *Research Methods for Business Students* (7th ed.). Harlow: Pearson Education.
- Saunders, M., Lewis, P. & Thornhill, A. (2019). *Research Methods for Business Students* (8th ed.). Boston: Pearson.
- Secord, A. (1996). Artisan Botany. In: Jardine, N. (eds.) *Cultures of Natural History*. Cambridge: Cambridge University Press, 378-393.
- Seyfried, G., Pei, L. & Schmidt, M. (2014) European Do-it-Yourself (DIY) Biology: Beyond the Hope, Hype and Horror. *Bioessays* 36(6), 548-551.
- Sleator, R. D. (2016) DIY Biology-Hacking Goes Viral. *Science Progress* 99(3), 278-281.
- Smith, W. L., Hillon, Y. C., & Liang, Y. (2019). Reassessing measures of sustainable firm performance: A consultant's guide to identifying hidden costs in corporate disclosures. *Business Strategy and the Environment*, 28(2), 353-365.
- Tanenbaum, J., Williams, A. Desjardins, A. & Tanenbaum, K. (2013) Democratizing Technology: Pleasure, Utility and Expressiveness in DIY and Maker Practice. In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 2603-2612), ACM.
- Tisdall, E. K. M., Davis, J. M. & Gallagher, M. (2009). *Researching with Children and Young People: Research Design, Methods and Analysis*. London: SAGE.

You, W., Chen, W., Agyapong, M. and Mordi, C. (2020). The business model of Do-It-Yourself (DIY) laboratories – A triple-layered perspective. *Technological Forecasting and Social Change*, 159, pp. 1-14.

UN Environment Program (2019), UN Environment and Saudi Arabia Sign Deal to Strengthen Environmental Protection. <https://www.unenvironment.org/news-and-stories/press-release/un-environment-and-saudi-arabia-sign-deal-strengthen-environmental> (Accessed: 20 May 2019).

Unterfrauner, E., Shao, J., Hofer, M., & Fabian, C. M. (2019). The environmental value and impact of the Maker movement—Insights from a cross-case analysis of European maker initiatives. *Business Strategy and the Environment*, 28(8), 1518-1533.

Walliman, N. (2010). *Research Methods*. Hoboken: Taylor and Francis.

Walliman, N. (2018). *Research Methods: The Basics*. London, New York: Routledge.

Wexler, A. (2016) The Practices of Do-It-Yourself Brain Stimulation: Implications for Ethical Considerations and Regulatory Proposals. *Journal of Medical Ethics* 42(4), 211-215.

Wolinsky, H. (2005) Do-It-Yourself Diagnosis: Despite Apprehension and Controversy, Direct-to-Consumer Genetic Tests are Becoming More Popular, *EMBO Reports* 6(9), 805-807.