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The Environmental Management Accounting for Supporting Green Innovation/Firm's Value with a Case Study

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Abstract

In the context of green innovation with its multidimensional aspects, traditional financial performance measures may not capture all performance areas. The green innovation environment requires new sorts of performance measures that can reflect the strategic objectives of firms oriented towards green sustainable development. Such performance measures can be established through the relevant environmental information provided by Environmental Management Accounting (EMA). Also, these measures are extracted through the employment of the Sustainability Balanced Scorecard (SBSC) approach and merging the strategic objectives of the firm with the SBSC strategy map. Thus, the aim of this thesis is proposing a new measurement framework to strategically measure the firm's performance in terms of the progress it achieves in coping with green innovation along with improving the firm's value. This is through establishing the most relevant green innovation performance measures that are derived from the determinants of the relevant environment for coping with green innovation. Such performance measures have to be constructed to promote the vision, mission and strategies of the firms coping with green innovation. In addition, this research was applied in Elaraby Group's washing machines factory, by conducting a case study in order to illustrate the applicability of the proposed framework.

Key Words: Environmental Management Accounting, Green Innovation, Green Innovation Performance Measures, Sustainability Balanced Scorecard.

المحاسبة الإدارية البيئية لدعم الابتكار الأخضر/قيمة الشركة مع دراسة حالة

(المستخلص)

في سياق الابتكار الأخضر بجوانبه المتعددة الأبعاد، أصبحت مقاييس الأداء المالي التقليدية لا تغطي جميع مجالات الأداء. تتطلب بيئة الابتكار الخضراء أنواعاً جديدة من مقاييس الأداء التي يمكن أن تعكس الأهداف الإستراتيجية للشركات الموجهة نحو التنمية المستدامة الخضراء، ويمكن إنشاء مقاييس الأداء هذه من خلال المعلومات البيئية الملائمة التي توفرها المحاسبة الإدارية البيئية. أيضا، يتم استخلاص هذه المقاييس من خلال استخدام نهج نموذج القياس المتوازن للأداء المستدام ودمج الأهداف الاستراتيجية للشركة مع الخريطة الاستراتيجية. وبالتالي، فإن الهدف من هذه الرسالة هو اقتراح إطار قياس جديد لقياس أداء الشركة بشكل استراتيجي من حيث التقدم الذي تحققه في التأقلم مع الابتكار الأخضر وتبنيه إلى جانب تحسين قيمة الشركة. وذلك من خلال وضع مقاييس أداء الابتكار الأخضر الأكثر صلة والمستمدة من محددات البيئة ذات الصلة لمواكبة الابتكار الأخضر. ويجب بناء مقاييس الأداء هذه لتعزيز رؤية ومهمة واستراتيجيات الشركات التي تتجه للتأقلم مع الابتكار الأخضر. بالإضافة إلى ذلك، تم تطبيق هذا البحث في مصنع الغسالات التابع لمجموعة العربي، من خلال إجراء دراسة حالة لتوضيح إمكانية تطبيق الإطار المقترح.

الكلمات الأساسية: المحاسبة الإدارية البيئية، الابتكار الأخضر، مقاييس أداء الابتكار الأخضر، بطاقة القياس المتوازن للأداء المستدام.

1. Introduction:

Preserving the environment has become an increasing concern for countries worldwide. This concern gained more importance after the industrial revolution due to the environmental impacts of industrial processes conducted by manufacturing companies aiming to satisfy the financial desires of their investors (Noah, 2017).One of the most important environmental impacts of manufacturing processes and activities in the industrial sector is climate change. The shrinking glaciers, the increase in sea level, the strong heat waves, along with other significant environmental issues represent climate change that needs to be taken into account (Andono, 2020).

Under the conditions of increased pollution and environmental issues, governments and policy makers have searched for solutions to overcome problems relating to the environment and pollution. For instance, several governments worldwide impose environment-related rules and regulations for companies to adhere to while running their manufacturing processes (Holt, 2005). These companies are also motivated to produce environment-friendly products to cope with the increased public awareness of customers which resulted in higher demand of green innovative products (Lin & Zhou, 2022). In fact, producing such products can help to enhance firm's value and reputation in the market, as it creates competitive advantages to the firm (Al-Abdallah & Al-Salim, 2021).

To meet the requirements of green innovation, companies should encompass environment-related information into their decisions using proper mechanisms, such as Environmental Management Accounting (EMA) (Derchi *et al.*, 2013). This study aims to propose a framework to measure the progress towards adherence to the requirements of green innovation along with improving firm's value.

2. Research Problem:

Environmental sustainability has become a primary concern in business organizations nowadays. The significance of this concern started back in the early 1980's and during the intervening years, it has become a crucial issue nowadays (Derchi *et al.*, 2013). This is because some natural resources are becoming in danger due to the harmful environmental impacts of manufacturing processes conducted in organizations (Holt, 2005).

Enterprises are now urged to issue reports to disclose information about their environmental performance in order to express their environmental and social responsibility to the public (Andono, 2020). They also attempt to engage in the environmental concern, by producing green innovative products, so that they can gain competitive advantage over other similar firms in the industry which produce traditional products (He *et al.*, 2021). This will enable the firm to have a better reputation, keep its image as a green business, build more customer trust and satisfaction, and enhance the firm's value and position in the market (Li *et al.*, 2019; Sari *et al.*, 2020).

However, producing green products requires organizations to adopt new innovative methods in their manufacturing processes and business activities. This means that they need to cope with green innovation with its different aspects; management, process, product and technological innovation, and to do so, firms try to use relevant systems and tools which enable them to assess the environmental impacts of their activities and account for and incorporate environment-related information into their decisions (Soderstrom *et al.*, 2017). Therefore, firms can implement environmental management accounting, as it provides relevant environmental information and measures which help them to control the environmental impacts of their business and express their environmental performance (Holt, 2005). Such measures can be derived from the aspects of green innovation and the features of its environment based on the Sustainability Balanced Scorecard (SBSC) as a strategic evaluation tool.

The current study aims to propose a measurement framework which helps to measure the progress achieved by firms in coping with green innovation along with improving firm's value. This can be accomplished through providing the relevant measures that help firms to eliminate any activities that have environmental impacts and instead choose activities that improve the firm's value but at the same time cope with green innovation.

In this regard, the research problem can be summarized in the following research question:

How to propose a measurement framework to measure the progress achieved by firms in coping with green innovation along with improving firm's value?

This research question can be divided into specific sub-questions as follows:

1.How can the implementation of EMA support the adoption of green sustainable development while enhancing firm's value?

2.What are the features of green innovation environment and the determinants of its measurement?

3. Research Objectives:

The main objective of this research is to propose a measurement framework to measure the progress achieved by firms in coping with green innovation along with improving firm's value in order to contribute to supporting sustainability development.

This study is guided by following objectives:

1.Emphasizing the role of EMA in supporting the adoption of green innovation.

2.Identifying the aspects of green innovation environment.

3.Deriving the effective measures that can be used to measure the progress in coping with green innovation along with improving firm's value.

4. Research Methodology:

In an attempt to establish the proposed measurement framework, the researcher uses the Constructive Approach. This approach refers to a method of research that aims at problem solving through the construction of organizational procedures, models, frameworks, diagrams, plans, etc. (Lukka, 2003). In order to help achieve the objectives of the study, a case study methodology was utilized on the Washing Machines Factory of Elaraby Group. Interviews were used along with documentary analysis, observation and questionnaires as methods of data gathering.

Since the SBSC is used in this study to derive measures and since there are plenty of measures, so it is required to choose the measures that are the most effective in achieving this study's goal which is measuring the progress in coping with green innovation along with improving firm's value. In order to test

measures, the Scoring Model is proposed as a quantitative model to analyze data and choose between measures as it can be easily used for multiple criteria decision-making purposes (Heidenberger & Stummer, 1999).

5. Research Significance:

1. It will create the chance for innovative ways to reduce environmental impacts while improving firm's value.

2.It will serve as an additional contribution to studies conducted in Egypt relating to green innovation through the implementation of the proposed measurement framework.

6. Research Delimitations:

The scope of this research study has been delimited by the following:

First: The researcher focused only on proposing a measurement framework convenient to measuring the progress achieved by a manufacturing firm in coping with green innovation along with improving the firm's value. However, the analysis of how such measurement framework will be different in the case when applied to service firms is not included within the scope of this research study.

Second: The researcher emphasized only the analysis of management accounting practices which serve the research framework and neglected the other tools. Also, when utilizing the sustainability balanced scorecard, the researcher placed more focus on the environmental pillar of sustainability than the social and economic pillars.

Third: The researcher selected only one firm to apply the proposed measurement framework because of the difficulty of obtaining complete information.

7. Literature Review:

7.1 Studies Related to EMA:

A study conducted by Sirisom & Sonthiprasat (2011) in Thailand indicated that the application of EMA helps to furnish the necessary relevant environment-related information that help to ease the adoption of Environmental Management Systems (EMS) and in turn improve firm's performance. Moreover, Al-Najjar and Anfimiadou (2012) discovered that eco-efficient businesses enjoy higher firm value in the UK market than those who don't engage in environmental initiatives.

Another study conducted by Elshishini (2013) indicated that there were significant relationships between the importance of EMA techniques and size, type of industry, and cost structure. Also, there were significant relationships between the benefits of EMA techniques and both of cost structure and type of industry. Furthermore, Yadav *et al.* (2016) discovered that the investors' top concern is environmental damage and businesses need to take it into account through improving their environmental performance, as continuous improvements in the environmental performance led to increased investors' expectations.

According to Burritt *et al.* (2019), companies applying EMA must utilize both monetary and physical environmental information together and not only one of them. Furthermore, Andono (2020) provided empirical evidence to the outstanding penetrated environment-related value into companies' key actors' daily activities and their practices of Environmental Management Accounting Control (EMAC).

7.2 Studies Related to Green Innovation:

Based on Tseng *et al.* (2012), adopting green innovation from its different aspects leads to establishing effective green strategies, minimizing polluting manufacturing processes and preserving the environment. Also, dealing with suppliers who commit to environmental rules can help companies to have a more successful supply chain through decreasing costs of compliance with environmental policies.

According to Wang (2019), organizational green culture has a significant positive effect on both green performance and competitive advantage, as this culture enables managers to run their business processes in a more environmentally-friendly attitude, which differentiates the firm in the market from its competitors. Moreover, Zhang *et al.* (2020) provided a framework for firms to investigate how ready they are for applying green innovation with regard to critical success factors which are presented from three aspects; technological, organizational and environmental preparedness.

Furthermore, Al-Abdallah and Al-Salim (2021) indicated that green product innovation can significantly and positively

influence the firm's competitive advantage. Also, the more the resources the firm has, the higher the influence of green product innovation on its competitive advantage, meaning that firm resources play a significant moderating role in the direct relationship between green product innovation and firm's competitive advantage. Another study conducted by Hu *et al.* (2021) illustrated that green subsidies offered by governments to green business firms, can positively affect both green product and process innovation initiatives in such firms.

7.3 Studies Related to SBSC:

According to Kang *et al.* (2015), firms can implement SBSC as a significant management tool that integrates (Corporate Social Responsibility) CSR into their organization's business and to develop an effective organization's management system which better realize the needs of different stakeholders. In fact, architectures of SBSC are mainly classified into two basic configurations; SBSC-4 which reflects four perspectives of the traditional BSC but with sustainability measures incorporated into them and SBSC-5, in which sustainability measures are included in an additional fifth perspective (Jassem *et al.*, (2022).

Based on Mio *et al.* (2021), the factors influencing the use SBSC included sustainability strategy, attention to interests of stakeholders, commitment of top management and culture, structure and size of the organization. In addition, some companies decide to add a fifth sustainability-related pillar to the traditional balanced scorecard to emphasize sustainability values; however, other companies incorporate sustainability measures fully into the four perspectives of the traditional balanced scorecard or partially into some of these perspectives.

8. Research Gap:

Drawing off the previous studies, it is clearly observed that the main focus is on the importance of adopting environmental management accounting and provided several implications for managers and policy makers. Studies also focused on explaining and supporting the relationships between EMA, green innovation, competitive capability and firm's performance and value. Thus, this study is a

response for the recent calls for research on the importance of implementing environmental management accounting as it will emphasize how the application of EMA can support coping with green innovation and enhancing firm's value.

9. Environmental Management Accounting (EMA):

9.1 Historical Background and Definitions of EMA:

EMA was adopted for the first time by a national agency back in the early 1990s when The US Environmental Protection Agency developed a formal program to encourage the adoption of EMA. After that, many organizations in more than 30 countries have started fostering and using EMA in several sorts of environment-related activities and initiatives (Jasch, 2006). The reason behind the development of environmental management accounting has been to overcome the limitations of traditional management accounting (Elshishini, 2013).

In fact, there is no one single definition of traditional management accounting. However, according to UNDSD (2001b), it can be referred to as identifying, gathering, assessing, analyzing and utilizing information in monetary form such as (costs, earnings, savings) and incorporating them in internal reporting for purposes of making decisions by an entity's management. Similarly, EMA has no single globally accepted definition.

Similarly, EMA has no single globally accepted definition. However, according to UNDSD (2001a) and IFAC (2005), it can be broadly defined as identifying, collecting, analyzing and utilizing physical information, Including the consumption and shares of water, energy materials and waste as well, and monetary information, including environmental costs, savings and earnings in order to be used for the purpose of internal decision-making (IFAC, 2005, p. 19; UNDSD, 2001a).

Thus, EMA represents a combined tool which depend on data obtained from financial accounting, balances of materials streams and cost accounting such as data about environmental costs in order to achieve a more efficient use of materials, minimize environmental hazards and decrease environmental protection costs (Jasch, 2003). Based on The Environmental Protection Agency (EPA), environmental costs are the internal costs which directly have a

financial influence on organizations and external costs, externalities or societal costs that reflect the businesses' social and environmental impacts for which the organization is not legally responsible (EPA, 1995). Internal costs include conventional, hidden, contingent and relationship and image costs, while external costs include costs of environmental damage and negative impacts on human beings (de Beer and Friend, 2006).

Among the main criticisms of traditional management accounting that led to EMA emergence include the following (Burritt, 2004):

- Environmental costs are not regarded as significant costs.
- Indirect environmental costs are improperly aggregated as they are included in general overhead expenses and then allocated to cost objects.
- Overemphasis on reducing periodic environmental costs and impacts instead of paying attention to opportunities of green environmental investments and profitability enhancement.
- Too much focus on production or manufacturing costs without considering the other phases of the product's life cycle.
- Lost relevance of traditional management accounting because of depending only on financial accounting information instead of relevant environmental information that internal management accounting needs in monetary and physical forms.

Thus, EMA has managed to provide effective solutions to the shortcomings of traditional management accounting through furnishing the necessary accurate information on the environment-related benefits and costs needed by decision-makers to evaluate and control the environmental impacts of their corporate activities (Gunarathne & Lee, 2021).

9.2 Fields of Applications of EMA:

Taking into account the monetary and physical aspects of EMA, Schaltegger *et al.* (2000) and UNDSD (2001a) demonstrated that the fields of application of EMA data can be classified as follows:

1. Past-oriented EMA tools:

- Physical data of EMA:

- Flow balances of energy, water and material.

- Evaluation and indicators of environmental performance, benchmarking.
- External environmental reporting and other reporting to authorities and agencies.

• Monetary data of EMA:

- Annual environmental costs or expenditures, transition from cost accounting and bookkeeping.
- External disclosure of environmental investments, liabilities and expenditures.

2. Future-oriented EMA tools:

• Physical data of EMA:

- Physical environmental investment appraisal and budgeting.
- Establishing targets for quantified performance.
- Design and application of environmental management systems, supply chain management, design for environment, pollution prevention, cleaner production, etc.

• Monetary data of EMA:

- Monetary environmental investment appraisal and budgeting.
- Calculating costs, benefits and savings of projects.

9.3 Benefits of EMA:

9.3.1 In Relation to the Environment:

Based on IFAC (2005), benefits of EMA can be classified into three groups as follows:

• Eco-efficiency: this means that EMA enables organizations to use materials and resources, such as water and energy, more efficiently in order to decrease the environmental impacts of their manufacturing processes and the environment-related costs altogether.

• Compliance: it means that EMA helps to promote environmental preservation through firm's compliance with environment-related rules and regulations imposed by governments and environmental policies adopted by the firm itself.

• Strategic position: which indicates that EMA assists organizations in maintaining their strategic position on the long run via evaluating and applying economical and environmentally-safe initiatives and strategies.

9.3.2 In Relation to Firm Value:

According to Staniskis & Stasiskiene (2006), EMA provides a linkage between firm's environmental performance and shareholder value as it helps the firm to address hidden environmental costs and enhance its environmental performance which, in turn, interprets raised shareholder value. In fact, application of EMA not only helps to better make managerial environment-related decisions, but also helps to enhance the performance of other managerial activities such as allocating and controlling costs, pricing products and designing processes and products (Staniskis & Stasiskiene, 2006).

Moreover, based on Al-Najjar & Anfimiadou (2012), businesses involving in eco-efficient practices are valued higher than those without such practices because they optimize their systems, and thus save time and costs and reduce risk and consequently improve their firm value. Furthermore, Yadav *et al.* (2016) indicated that the firm's environmental impact is the most significant factor influencing its value. Thus, as long as the firm has a strong environmental performance, this will positively affect its value in the market.

Therefore, firm value can significantly increase with improved environmental management due to the fact that stakeholders, including local communities, businesses, customers, public institutions and governments have begun to understand the significance of corporate environmental performance in recent years (Choi *et al.*, 2020).

10. Green Innovation:

10.1 Definitions, Types and Importance of Green Innovation:

Despite numerous attempts that have been made in the literature, it is difficult to define green innovation (Carrillo-Hermosilla *et al.*, 2010). However, Green innovation can be defined as innovation in hardware or software that is relevant to green processes or products, such as technological innovations in waste recycling, energy saving, pollution prevention, green product design, or corporate environmental management (Chen *et al.*, 2006, p.332). Green innovation can also be referred to as the organization's establishment of ecofriendly and ecological processes and

products which are less harmful to the environment (Albort-Morant *et al.*, 2018).

According to Chen *et al.* (2006), green innovation can be classified into two main types; green product innovation and green process innovation. Green product innovation can be referred to as developing new products or enhancing existing ones significantly aiming mainly to reduce the negative environmental consequences of making and using these new or enhanced products (Afum *et al.*, 2021). It can also be defined as the use of organic materials or nonpolluting combinations to adjust or improve the products' design and the production of energy saving and for the environmental protection of new products (Melander, 2018).

Green process innovation can be defined as the natural set of green processes which result in efficient energy use, enhance products' quality and decrease harmful environmental impacts of production processes (Jaramillo *et al.*, 2019). Based on Tseng *et al.*, (2012), types of green innovation can also include management innovation and technological innovation. On one hand, management innovation means that an entity should seek continuous improvement through establishing green innovative strategies and goals that can be achieved within the specified budget for accomplishing them and in compliance with firm's day-to-day operations. On the other hand, technological innovation is a strategic tool not only for producing green products, but also for gaining competitive advantages among other firms in the industry (Tseng *et al.*, 2012).

10.2 The Factors Leading to the Adoption of Green Innovation:

There are several factors that drive firms to adopt green innovation. For instance, some governments encourage firms to foster green innovative practices and processes through providing them with financial rewards and subsidies, tax exemptions and easily accessible credit from public banking institutions (EIO, 2011; Hojnik & Ruzzier, 2016; Jun *et al.*, 2021). Also, governmental rules, regulations and environmental policies push firms to implement green innovation (Foster & Green, 2000). This is because non-compliance with governmental legislation on environment preservation could cause businesses to bear significant costs and fines (Berrone *et al.*, 2013).

Moreover, environmentally friendly products can serve as a motivator for businesses to win a substantial market share (Green *et al.*,1994).In fact, the tendency of consumers to prefer purchasing green sustainable products to other regular products forms a reason for industrial companies to be encouraged to spend more in green practices (Abdullah *et al.*, 2016). Additionally, spending more in green innovating technologies can help businesses to improve their performance and gain the chance of acquiring a competitive advantage in the marketplace (Jun, *et al.*, 2021). Thus, firms ought to take competitors who run green businesses into account when developing their business strategies (DeBoer *et al.*, 2017). Consequently, the utilization of green technologies will assist a firm in obtaining environmental accreditation, which enhances the image of the company as a whole.

10.3 Green Innovation Aspects and Measurement System:

In order for firms to cope with green innovation with its different aspects, represented in its four types; management, process, product and technological innovation, Tseng *et al.* (2012) has provided several criteria to help measure how well the firm performs with regard to each aspect of green innovation as follows:

Table 1: Criteria for coping with aspects of green innovation

Aspects of Green Innovation	Criteria for Coping with Each Aspect
Management innovation	- Apply an environment-oriented supply chain management through reassessing and enhancing the efficiency of business operations and internal production processes. - Creating new designs for business products and services or enhancing them in order to meet management's new environmental strategies. - Decreasing dangerous waste and releases of polluting substances. - Efficient use of electric energy and natural resources, such as water, oil, natural gas and so on. - Implementing an adequate environmental management system and standards of ISO 14000 to ensure effective management of organization's environmental responsibilities. - Encouraging stakeholders to be more environmentally-conscious through training and meetings.
Process innovation	- Efficient use of materials, electric energy, oil and water from producing the product until disposing it. - Using recyclable materials and reprocess them. - Obtaining green technologies that help to stop pollution, save energy, and water and provide better waste management tools. - Assessing suppliers' compatibility with the environment through firm's internal auditor. - Improving R&D roles and consider environmental matters when designing business processes. - Seek a cost-effective provider of green energy.

(Source: Tseng *et al.*, 2012, p. 239)

Product innovation	– Meeting consumers' expectations and environmental awareness by producing competitive green products. – Assessment of green innovative products in terms of their economic, practical, and commercial usefulness. – Recycling of organization's obsolescent products. – Using eco-labeling, environment management system and ISO 14000. – Adopting ISO 14000 standards, using eco-labels to identify environmentally friendly products and maintaining an effective management system. – Innovation of green products and design measures. – Creating innovative designs and green products.
Technological innovation	– Making prosperous investments in green technologies and eco-friendly assets. – Application of inclusive policy that prevents materials waste. – Implementing and adequate control system to monitor transfer of organization's technology. – Obtaining modern eco-friendly technologies that result in green methods of production. – Managing technological information and documenting them adequately.

Thus, according to Zhang *et al.* (2020), green innovation can be considered as a multi-dimensional concept as it involves several activities from different aspects as indicated in the previous table. Each of these aspects represent the main determinants or elements of green innovation and contributes to its implementation at different levels as follows (Zhang *et al.*, 2020):

- Green management innovation is focused on innovating the firm's administrative policies and procedures as a whole.
- Green process innovation is focused on innovating the firm's internal business operations.
- Green product innovation is focused on the outside market of the firm.

10.4 Benefits of Coping with Green Innovation:

Customers nowadays have become more aware of the negative impacts of polluting manufacturing processes on the environment and are now in demand of green environmentally friendly products (Amato & Amato, 2012; Lin *et al.*, 2013; Zhou *et al.*, 2005). Taking into consideration such demands of customers, firms should develop green innovative manufacturing processes and deliver

green products and services to customers, which will in turn increase firm's sales (Lin *et al.*, 2013). Coping with market changes and meeting customers' demands not only helps in increasing the firm's sales, but also it contributes to maintaining and enhancing its reputation in the market as a green business that takes into its consideration the environmental concerns (Tang *et al.*, 2012).

In addition, coping with green innovation help improve the firm's environmental performance through adhering to environmental regulations and sustainability guidelines and lessen environmental consequences (Abu Seman *et al.*, 2019; Chiou *et al.*, 2011; Huang & Li, 2017). This can then lead to the improvement of the financial performance of the firm through the reduction in operational costs yielded from avoiding fines associated with non-compliance with environmental rules and regulations (Afum *et al.*, 2021).

Therefore, it can be concluded that the better the environmental performance of the firm, the higher its financial performance (Centobelli *et al.*, 2019). Eventually, coping with green innovation can positively influence firm's value through improving its financial performance (Asni and Agustia, 2022). Hence, investors in the capital market tend to economically motivate firms to implement green innovation. This is because the profitability yielded from a firm's capability to continuously innovate positively affect value creation by manufacturing firms (Asni & Agustia, 2022).

Furthermore, Sajan *et al.* (2017) revealed that the economic and the social performances of firms can positively and highly correlate to their environmental performance. According to Afum *et al.* (2021), the enhanced social performance of the firm can be reflected in elevating business's reputation in the market as a green eco-friendly business firm, enhancing employees' convenience, through protecting their health, well-being and safety, and increasing the standard of living for citizens. All these benefits are significantly preceded by enhanced environmental performance through emission reduction, cleaner air, efficient consumption of resources and energy, and minimization of waste (Afum *et al.*, 2021).

More research studies, such as Bonifant *et al.* (1995); Guziana (2011); Yalabik & Fairchild (2011), also confirms that green innovation can positively affect firm performance and enable the firm to gain a competitive advantage through creating sustainable green products, enhancing production efficiency, and improving the effectiveness of management.

10.5 Features of Green Innovation Environment:

In order for business firms to successfully cope with and implement green innovation with its different types and aspects, and to effectively advantage from its adoption, they should be aware of the determinants that shape the features of green innovation environment. These determinants represent the circumstances, variables, causes, and practices that are regarded as essential factors resulting in the development of green innovation (Chen & Chang, 2013; Tariq *et al.*, 2017). Based on several studies in previous literature relating to green innovation such determinants can be summarized as follows (Serrano-García *et al.*, 2021):

- Green products innovation-focused planning: the development and execution of corporate mission, programs, strategic plans, policies, whether on the short, medium, or long term, and organization's goals for the purpose of achieving green product innovation.
- Green process and product design: planning, designing, creating, and managing environmentally friendly processes and products.
- Environmental management system: the establishment and application of an accredited environmental management system.
- Developing environment-related technologies: employing environmentally friendly methods and technologies that cut emissions for the purpose of designing, producing and distributing green innovative products.
- Green labelling, packing, and packaging: more readily recyclable, reusable, and/or quickly decomposable product packaging that is cleaner, lighter, and more ecologically responsible.
- Human potential with green product innovation capabilities: human capital with in-depth understanding of ecological and sustainable development to encourage the establishment and coordination of groups and multifunctional processes, and the interaction among these processes for the development of green products.

- Accountability across the product's life cycle: environmental qualities are incorporated into the design of the product and throughout its life cycle as part of the organization's duty for innovating green products.
- Adherence to environment-related legislation: in order to encourage green products development, climate policies and environment-related rules and standards must be understood, identified, and followed.

Therefore, it can be concluded that the features of green innovation environment can be identified across the several aspects of green innovation. Once these features are perceived properly by business firms, they can then effectively utilize and benefit from green development.

11. The Proposed Sustainability Balanced Scorecard (SBSC)-Based Measurement Framework:

11.1 Historical Background of the Balanced Scorecard (BSC):

BSC was first created by Kaplan and Norton in 1992. They criticized businesses for considering only financial metrics to evaluate their corporate performance, as these metrics are condemned for their short-term orientation and limited perspective on corporate performance and firm's capability of creating value. BSC is described as an effective tool that serves as the foundation for a strategic management and measurement system through translating a company's organizational strategies and mission into a complete set of performance metrics (Kaplan & Norton, 1996b).

In fact, BSC has evolved through time into several generations. Based on Kaplan & Norton (1992), the initial BSC proposes monitoring performance across four perspectives (financial, customer, internal business, and innovation & learning) to create a more "balanced" assessment of organization's performance. Each of the BSC's four perspectives has its own impact on the performance of the business firm. According to Kaplan & Norton (1992), these four perspectives can be illustrated as follows:

- **Customer perspective:**

According to this perspective, the organization must take into account what the client desires or anticipates, and develop performance measures that guarantee that the business is operating at an optimal level. Based on Kaplan & Norton (1992), the four key areas of client's worries typically are, product quality, timing, pricing, and support and performance.

- Internal business perspective:

Based on this perspective, the firm must concentrate on the conducting its internal processes effectively and only employ measures that are centered on activities that have a significant influence on how the business is run. The length of the life cycle of the product, costing, marketing time, and productivity are a few examples of these measures.

- Innovation and learning perspective:

Due to the growing external demands of international competition, this perspective forces the business firm to think about the extent to which it can grow and make improvements regarding its performance as well as how well it is able to adapt to shifting circumstances. The measures typically center on the employees' happiness and enhancement of their knowledge and skills as well as the observation of innovative services or products with a particular focus on innovation.

- Financial perspective:

This last perspective has historically been the primary measurement for business firms; financial performance. The financial dimension in the balanced scorecard can be seen as a monitor on previous results of performance, while the remaining three dimensions can be seen as the dimensions driving to the future performance of the firm.

Based on Kaplan & Norton (1992; 1996a; 2001; 2004a), first, the firm's development of the vision and objectives forms the basis for BSC application. Then, following the identification of its vision and objectives, and depending on analyzing the profit chain or the value chain, a company conducts a systematic examination of the pertinent elements necessary to achieve the planned strategies (Heskett *et al.*, 1994; Porter, 1985). After that comes the

determination of the important performance factors that are unavoidably required to carry out the specified strategies so as to realize the company's mission and vision (Kang *et al.*, 2015).

Actually, the balanced scorecard's cause-and-effect relationships across all its dimensions included in a strategy map are one of its distinguishing features (Kaplan & Norton, 2000; 2004a). This is beginning with the company's staff members, and then continues through corporate processes and consumers, ultimately improving financial performance of the company. Since their impacts are evident in the Financial perspective, the Learning & Growth, Internal Processes, and Consumers perspectives include the operational measures that are referred to as leading indicators, while the financial measures in the financial perspective reflect the lagging results that are a consequence of conducting and continually assessing the activities that affect leading indicators (Kaplan, 2010).

11.2 The Drawbacks of the Balanced Scorecard:

Although the balanced scorecard has been an effective strategic tool in helping business firms in managing and monitoring their performance, however, the balanced scorecard has also come under some criticisms.

For instance, Neely *et al.* (1995) criticized the absence of a competitive dimension in the balanced scorecard. They argued that the management that only develops measurements on the basis of the four dimensions of the BSC; financial, customer, internal business processes, and innovation & learning, would be unable to respond to the crucial query of what the firm's rivals are doing. Further, according to Neely (2002), the balanced score card is also criticized for not incorporating more perspectives relating to other concerns such as satisfaction of employees or human resources, quality of the products and services provided by the firm, competition, performance of the firm's suppliers and raising concerns relating to social and environment-related responsibility. Thus, since the BSC is not considering all measurements, this can weaken its inclusiveness (Neely, 2002).

Brignall (2002) also supported the fact that the balanced scorecard needs a perspective that reflect measures relating to social and

environment-related issues. Therefore, due to these criticisms and in order for business firms to be able to take into consideration the increasing concerns relating to sustainability and cope with the emerging challenges and competitive environment surrounding them, it has become crucial to utilize a more developed version of the BSC so as to address such challenges.

Furthermore, Kaplan (2010) pointed out that in order to make the BSC ideally equipped to and in line with corporate plans and objectives, the dimensions of BSC can be increased or decreased. This actually has paved the way for SBSC to emerge as illustrated in the following section.

11.3 The Emergence and Development of SBSC:

Sustainability balanced scorecard has emerged as a consequence of neglecting emerging issues relating to sustainability by the standard balanced scorecard's four perspectives; financial, consumers, internal processes, and learning and growth perspectives (Hansen & Schaltegger, 2012). This led to the necessity of the adaptation to the evolving corporate environment (Jassem *et al.*, 2022).

Thus, the sustainability balanced scorecard offers an effective tool for a comprehensive management of sustainable development. This is because it substantially aids in overcoming the drawbacks of the frequently similar management systems utilized previously for monitoring the issues related to the environment, society, and economy (Figge *et al.*, 2002).

Based on Figge *et al.* (2001b; 2002), an SBSC can be constructed by integrating environmental and social aspects in the four traditional perspectives of BSC. In this format of SBSC, the environmental and social aspects that are strategically relevant are subsumed under the four perspectives of BSC. For example, In the customer perspective, the core measure, "market share," would have an environmentally conscious dimension for a company that targets the environmental client category. Additionally, the "product features" leading indicator would include an environmental aspect (Figge *et al.*, 2001b; 2002).

According to Kang *et al.* (2015), the sustainable aspects included within an SBSC have a substantial effect on the Learning & Growth, Internal processes, and Consumer perspectives, which in turn influences the Financial perspective. Therefore, the SBSC encourages

all business activities to be coordinated and managed in accordance with their strategic value and guarantees that environmental and social factors are fully incorporated into the overall management system (Kang *et al.*, 2015).

11.4 The Proposed Measurement Framework:

The process of establishing an SBSC can be split into three steps which can be presented as follows (Figge *et al.*, 2001b; 2002):

1) Choose a strategic business unit. This stage assumes that the business unit has a strategy in place.
2) Determine the social and environmental engagement.
3) Identify the strategic value of social and environmental factors of the business unit.

As Kaplan and Norton (1997) suggested a top-down approach for the construction of a BSC to identify the aspects with strategic importance in all dimensions and connect them in a hierarchy with the long-term achievement determined by the financial dimension, this method can also be applied to the construction of an SBSC. However, the only distinction is that not just traditional factors but also strategically relevant social and environment-related factors must be taken into account and incorporated into the scorecard system based on their strategic significance (Figge *et al.*, 2002).

Based on Kaplan and Norton (2000), a strategy map can be utilized in order to assist in visually illustrating the outcome of the process of constructing a sustainability balanced scorecard. When creating this strategy map, the hierarchical pattern of causation linkages reflects all financial, social and environment-related factors that have been determined to be strategically significant. A firm's sustainability balanced scorecard can be displayed as a strategy map as shown in the following figure (figure1).

According to this strategy map shown in figure, the strategically relevant environmental and social factors are integrated into the overall management system according to their strategic relevance. This is through incorporating them into the SBSC just as "conventional" success factors. The following stage is to develop indicators, goals, and measurements to monitor and guide business performance to be directed to the attainment of significant

business participations in sustainable development (Figge *et al.*, 2002). In this stage, the real work of developing the measurement framework begins as it entails the extraction of measures for a firm's green innovation performance measurement customized by SBSC perspectives. This stage can be conducted through three steps as follows (Figge *et al.*, 2001b; 2002):

1) Identifying the strategic objectives:

In this step, the firm's main business strategy is examined and translated into strategic objectives, which helps to connect the various elements of the strategic performance measurement system by deriving the objectives from the strategy and cooperating and interacting between objectives to accomplish the strategy. Such objectives define the intended results that the company wants to attain, and one or more performance measure(s) are used to track progress achieved towards attaining the desired results.

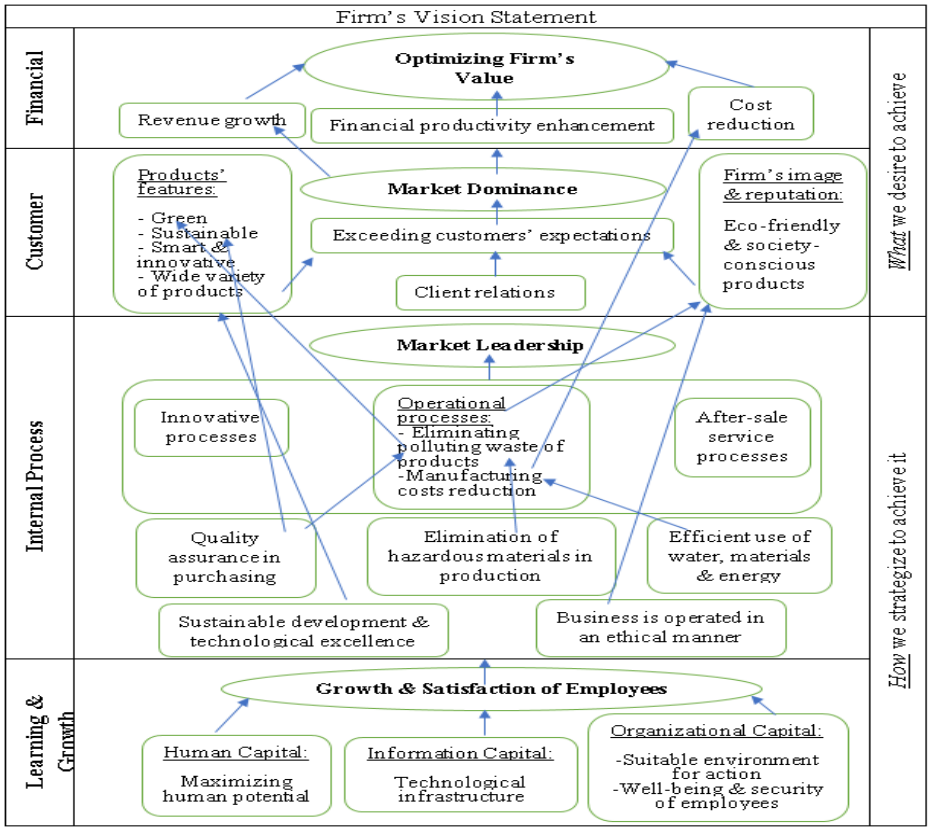

Figure 1. A firm's sustainability balanced scorecard displayed as a strategy map (Source: The Researcher)

1) **Identifying the Critical Success Factors (CSFs) for the firm:**

To continuously enhance processes and customer relations, the firm must ascertain which product features will produce the best value for its customers as well as what employee skills, information infrastructure, and organizational environment are required.

2) **Developing the relevant strategic performance measures:**

Strategic measures are aligned with the identified strategic objectives and are used to evaluate and measure the success of achieving the business as planned and changed.

Accordingly, in order to construct the proposed measurement framework of this study, the researcher can select some of the relevant performance measures stemmed from the features of green innovation environment for each SBSC perspective. Such measures can be derived from the relevant factors in literature that critically affect the firm's performance in coping with environmental practices and green initiatives.

The selected relevant performance measures for the proposed measurement framework of this study are better illustrated in the next section through conducting a case study on Elaraby Group's washing machines factory and identifying its strategic objectives and critical success factors. In order to measure the progress achieved by the factory under study in coping with each aspect of green innovation, the researcher will assign the measures that are most relevant to each of these aspects.

12. The Case Study:

12.1 Case Study Research:

The case study approach is an empirical investigation into a current phenomenon in its real-world setting, particularly when there are no clear boundaries between the object or phenomenon and the context in which it occurs (Yin, 2003). This approach is suitable for this research because case studies are most commonly used in the social sciences, and they have proven to be particularly useful in practice-oriented disciplines (e.g., management, teaching, public administration, welfare work and social services) (Rebolj, 2013).

12.1.1 Unit of Analysis:

Elaraby Group was founded in 1964 as a joint stock family business and has since expanded to become one of the biggest manufacturing and commercial organizations, not only in Egypt, but also in Africa and in the Middle East. Elaraby Group runs its business through 16 manufacturing, commercial, healthcare, and service firms in four separate governorates with 35 industrial facilities and two hospitals. The number of employees at Elaraby Group approached 40,000 employees during the year 2020. The brand portfolio of Elaraby Group includes 17 international brands which involve 26 categories of products, as well as more than 4000 variants.

Elaraby Group's aim is represented in becoming the best company among the African Egyptian and Arabian companies competing in the market by the end of the year 2023. This aim is concluded from the vision and mission of the company. The vision of Elaraby Group is to consistently earn the trust of clients and partners by providing trademarks, services and products that contributes to the society. The mission of Elaraby Group is represented in preserving the confidence of its clients and business partners. This is achieved through the dedication of Elaraby Group to the following (https://www.linkedin.com/company/elarabygroup/about/):

- Offering appliances and electronic devices for consumers that are of high-quality specifications within domestic and overseas markets.
- Developing business relationships with vendors that benefit both parties.
- Improving the efficacy, efficiency, productivity, and happiness of employees.
- Creating a prestigious, family-like work atmosphere.
- Upholding the organizational stated principles of the business.

- Performing as a socially responsible business that makes contributions to its society.
- Enhancing the organization's values

Elaraby Group presently comprises of six industrial businesses which started with home appliances factories. Among such factories is the washing machines factory which has been selected by the researcher to serve as this research study's unit of analysis. This factory provides 20 different models of top loading washing machines of the brand Toshiba with different colors, capacities and prices to satisfy customer needs(https://www.elarabygroup.com/en/shop-elaraby-brands/Toshiba-products/Toshiba-washing-machines).

12.1.2 The Reasons Behind the Unit of Analysis Selection:

The researcher has chosen to select one of Elaraby Group factories as a unit of analysis for the conducted case study in this thesis due to the following reasons:

- Elaraby Group Company applies the technology and thought of Japan by obtaining the agency of the Japanese-origin Toshiba International Company, where it applies several aspects of green innovation, and therefore the researcher saw that this company is considered a suitable environment for applying the proposed framework.
- The strategic objectives that the company desires to achieve, represented in providing innovative products that are characterized by the international level of quality, continuous improvement of performance, rationalization of costs, maximization the firm's value, and performing as a socially responsible and environmentally aware company are the same objectives on which the proposed framework is based.

12.1.3 Data Collection Methods:

In order to get an in-depth understanding of the currently applied performance measurement techniques by the factory under this study as well as how far this factory is coping with green development, the researcher used a variety of data gathering techniques, including non-participant observations through taking

a factory tour, interviews with the general manager of the factory and an engineer from the factory in addition to documentary analysis from online resources provided by the company. The researcher also utilized survey questionnaires that include a list of inquiries about the performance measurement strategies already in use at this factory. This is for the purpose of developing a relevant strategic system for measuring performance through effectively implementing the performance measurement framework proposed by this study depending on SBSC.

12.2 Data Analysis:

12.2.1 The Manufacturing Processes at The Washing Machine Factory of Elaraby Group:

There are multiple manufacturing processes conducted at the factory of to provide the final products as follows:

1- The process of forming the metal cabin:
During this manufacturing process, metal sheets are passed through four pistons and a roller to make the metal cabin.

2- The process of assembly:
Each washing machine unit takes around 25 minutes to be assembled together.

3- The process of quality assurance:
During this process, a thorough test on a sample of 24 manufactured washing machines is conducted to confirm the quality of the final product.

4- The process of packaging:
The time required to conduct this process is around 3 minutes.

5- The shipping process:
Orders from consumers are prepared and dispatched right away.

12.2.2 Customization of Green Innovation Performance Measures Based on Sustainability Balanced Scorecard (SBSC) Perspectives for Elaraby Washing Machines Factory:

The researcher customized the recommended performance measures for Elaraby washing machines factory in order to evaluate the continuous improvement achieved with regards to the performance ¬goals stemmed from the operationally informed

business strategy. This was conducted through the extraction of measures for the firm's green innovation performance measurement customized by SBSC perspectives by following the three steps, identification of objectives, determination of CSFs and development of relevant performance measures. This can be illustrated in the next table as follows.

Table 2. Objectives, CSFs and performance measures for Elaraby Group's Washing Machines Factory (Source: The Researcher)

The Main Objectives Objectives of The Washing Machines Factory	SBSC Perspectives	CSFs	Relevant Performance Measures
Maximizing shareholders' wealth. Maximizing firm's utilization of energy and resources. Penetrating new markets. Meeting customers' expectations through the timely delivery of high-tech products at the lowest possible price. Providing a safe and healthy work environment to promote green innovation through encouraging employees to adapt to sustainable development initiatives. Employing highly skilled labor to provide products that exceed customer needs and correlating training programs with business results.	1. Learning and growth perspective	o Innovation. o R&D of green technologies. o Employee satisfaction: - Employee morale and engagement. - Employee retention. - High skilled employees.	1.1 No. of international green certifications 1.2 No. of firm's innovation processes or patents per year. 1.3 No. of R&D of firm's annual green technologies. 1.4 Strategies to prevent/minimize biodiversity and shocks to the ecosystem (such as no. of ecological restorations). 1.5 No. of employee suggestions implemented. 1.6 Employee turnover. 1.7 No. of training hours for each employee.
	2. Internal business process perspective	o Elimination of waste. o Energy efficiency. o Manufacturing process efficiency. o Pollution management. o Green purchases. o Water resources management. o Green supply chain management (GSCM). o Product management and recycling mechanism.	2.1 Waste reduction rate. 2.2 Amount of energy consumption. 2.3 Overall Equipment Effectiveness (OEE). 2.4 Amount of Greenhouse Gas (GHG) emissions and gas leaks per year and strategies to prevent pollution. 2.5 No. of green raw materials purchased by the firm. 2.6 Amount of water consumed. 2.7 Has the firm established a green supply chain management system? 2.8 Has the firm established an effective product management and recycling mechanism?
	3. Customers perspective	o Customer satisfaction. o High Quality, society-conscious and eco-friendly green products.	3.1 Customer retention rate. 3.2 No. of customers' complaints.
	4. Financial perspective	o Cost reduction. o Revenue growth. o Financial productivity.	4.1 Product cost per unit. 4.2 Revenue growth rate. 4.3 Ratio of Return on Capital Employed (ROCE).

Through the previous table, the researcher suggested a number of CSFs and performance measures which should be considered to achieve a better performance management. Such performance measures are derived from the strategic plans (vision) of Elaraby Group's washing machines factory. These measures determine the concept and sources of value creation to customers, the CSFs which are incorporated within the performance measurement system, and the sorts of wastage and environment-related issues included in business's activities and processes of production and methods of their elimination in order to cope with green innovation initiatives and reach sustainable development.

12.2.3 Scoring Model:

In this study, the main goal is to help the firm measure the progress it achieves in coping with green innovation in terms of each of its four aspects while improving the value of the firm. The aim is to determine which performance measures are the most effective in achieving this goal. So, the researcher considers such performance measures to be the decision alternatives of the scoring model. The aim is to rank those performance measures as to their contribution in achieving the main goal of coping with green innovation in terms of each determinant or aspect of green innovation.

The necessary steps for developing a scoring model are as follows (Anderson *et al.*, 2015):

1. Create a list of the relevant criteria to be taken into consideration in order to evaluate each decision alternative.
2. Each criterion is assigned a weight to represent its relative importance. Let $Wi = the\ weight\ for\ criterion\ i$
3. Each criterion is given a ranking to indicate the extent to which it is satisfied by each observation (each decision alternative). Let

   $$Rij = the\ rating\ for\ criterion\ i\ and\ decision\ alternative\ j$$

4. The score is calculated for each observation (each decision alternative). Let

   $$Sj = the\ score\ for\ decision\ alternative\ j$$

   To calculate Sj, the following equation can be used: $Sj = \sum_i^m Wi\ Rij$

5. The observations are ranked in decreasing order of score to provide the most desirable decision alternative which is then the one that received the highest score.

The previous steps were followed by the researcher to implement the scoring model. First, a weight is assigned to each of the considered criteria in order to show the extent to which each criterion is relatively significant while making decisions, depending on a five-point scale as in the following table:

Table 3. Weights for the criteria of coping with aspects of green innovation environment (Source: The Researcher)

Criteria (Determinants of Green Innovation Measurement)	Weight (Wi)	
Management innovation	$W1$	24.8%
Process innovation	$W2$	24.8%
Product innovation	$W3$	25%
Technological innovation	$W4$	25.4%
	ΣWi	100%

Second, a weight is assigned to each of the considered criteria in order to show the extent to which each criterion is relatively significant while making decisions, depending on a five-point scale as in the following table:

Table 4. Ranking for each combination of a decision alternative and a decision criterion (Source: The Researcher)

Criteria	Decision Alternatives				
	1	2	3	...	n
Management innovation	R11	R12	R13	...	R1n
Process innovation	R21	R22	R23	...	R2n
Product innovation	R31	R32	R33	...	R3n
Technological innovation	R41	R42	R43	...	R4n

After ranking the four criteria and settling the outcomes of the measurements, the ultimate set of criteria / alternatives and their

order of importance will then be decided. Lastly, the rest of the decision alternatives' scores are calculated in a similar way as in the next table.

Table 5. Calculations of scores for each of the 'n' decision alternatives (Source: The Researcher)

Criteria	Weight (Wi)	Decision Alternatives						
		1		2		...	n	
		Ranking $Ri1$	Score $WiRi1$	Ranking $Ri2$	Score $WiRi2$	...	Ranking Rij	Score $WiRij$
Management innovation	$W1$	$R11$	$W1R11$	$R12$	$W1R12$	...	$R1n$	$W1R1n$
Process innovation	$W2$	$R21$	$W2R21$	$R22$	$W2R22$	...	$R2n$	$W2R2n$
Product innovation	$W3$	$R31$	$W3R31$	$R32$	$W3R32$	...	$R3n$	$W3R3n$
Technological innovation	$W4$	$R41$	$W4R41$	$R42$	$W4R42$	...	$R4n$	$W4R4n$
Score $(Sj) = \sum_{i=1}^{4} WiRij$		$\sum_{i=1}^{4} WiRi1$		$\sum_{i=1}^{4} WiRi2$		...	$\sum_{i=1}^{4} WiRin$	

12.3 Results of the Case Study:

12.3.1 First: The Importance of Each Determinant of Green Innovation Performance Measurement Framework for Elaraby Washing Machines Factory:

a) For the first criterion (Management innovation), the researcher calculated the cut-off score to be = 4.33.

b) For the second criterion (Process innovation), the researcher calculated the cut-off score to be = 4.33.

c) For the third criterion (Product innovation), the researcher calculated the cut-off score to be = 4.36.

d) For the fourth criterion (Technological innovation), the researcher calculated the cut-off score to be = 4.43.

More analysis of the findings on the weights of the four selection criteria determinants revealed that 'technological innovation' is considered as the most important criterion for the washing machines factory of Elaraby Group as it received an average of 4.43. Then, 'product innovation' is considered as very important criterion for the factory as it received an average of 4.36. Finally, the 'management innovation' and the 'process innovation' are considered very important criterions and they share the same importance for the factory as they both received an average of 4.33.

Based on the previous results, the factory should pay more attention to 'technological innovation' determinant as it has the most

importance among other determinants for coping with green innovation. The adoption of green high-tech innovations can indeed enable the firm to cope successfully with green innovation. This is because green technological innovation can be used by firms as a strategic tool that can help firms not only in the production of green environmentally-safe products, but also in the gain of competitive advantages among other competing firms in the industry.

This requires that the performance measures should emphasize measuring the firm's performance in adopting new green technologies and ensuring that employees are provided with sufficient training programs on such technologies. This can eventually help in achieving green patents that enable the firm to enhance its value in the market and be distinguished from its rivals through maintaining its image in the society as a pioneering green business.

The weights calculated are based on subjective values obtained from the employees of Elaraby Group washing machines factory. Most likely, different employees would decide to give weights to the criteria in a different way. Thus, the scoring model's use of subjective weights, which most accurately reflect the individual decision maker's preferences, is one of its main advantages.

12.3.2 Second: The Extent to which Each of The Performance Measures is Contributing to Achieving Each Determinant of The Green Innovation Performance Measurement System Customized by SBSC Perspectives

The second study's objective was to identify the relative importance of each performance measure in the washing machines factory. This is for the purpose of determining the performance measures that are the most effective in measuring the firm's achieved progress in coping with each of the determinants of green innovation.

First, the scores for each observation within each criterion are computed for Elaraby washing machines factory. Then, the total score is computed for each observation in order to rank the examined decision alternatives and identify the best decision alternative to recommend. This is illustrated in tables 6, 7, 8 and 9, respectively.

Table 6. Scores computations for management innovation performance measures for Elaraby Group's washing machines factory (Source: The Researcher)

Performance Measures	Weight of Management Innovation Criterion *Wi*	Rating of Management Innovation Criterion and Each Observation *Rij*	Score of Each Observation *Wi Rij*
Strategies to prevent/minimize biodiversity and shocks to the ecosystem (such as no. of ecological restorations)	0.248	4.10	1.017
Amount of Greenhouse Gas (GHG) emissions and gas leaks per year and strategies to prevent pollution	0.248	4.14	1.027
Has the firm established a green supply chain management system?	0.248	4.14	1.027
Has the firm established an effective product management and recycling mechanism?	0.248	4.36	1.081
Ratio of Return on Capital Employed (ROCE)	0.248	4.33	1.074

Table 7. Scores computations for process innovation performance measures for Elaraby Group's washing machines factory (Source: The Researcher)

Performance Measures	Weight of Process Innovation Criterion *Wi*	Rating of Process Innovation Criterion and Each Observation *Rij*	Score of Each Observation *Wi Rij*
No. of employee suggestions implemented	0.248	4.38	1.086
Employee turnover	0.248	3.71	0.92
Waste reduction rate	0.248	4.60	1.141
Amount of energy consumption	0.248	4.5	1.116
Overall Equipment Effectiveness (OEE)	0.248	4.48	1.111
No. of green raw materials purchased by the firm	0.248	4.07	1.009
Amount of water consumed	0.248	4.07	1.009

Table 8. Scores computations for product innovation performance measures for Elaraby Group's washing machines factory (Source: The Researcher)

Performance Measures	Weight of Product Innovation Criterion Wi	Rating of Product Innovation Criterion and Each Observation Rij	Score of Each Observation $Wi\ Rij$
Customer retention rate	0.25	4.31	1.078
No. of customers' complaints	0.25	4.45	1.113
Product cost per unit	0.25	4.24	1.06
Revenue growth rate	0.25	4.19	1.048

Table 9. Scores computations for technological innovation performance measures for Elaraby Group's washing machines factory (Source: The Researcher)

Performance Measures	Weight of Technological Innovation Criterion Wi	Rating of Technological Innovation Criterion and Each Observation Rij	Score for Each Observation $Wi\ Rij$
No. of international green certifications	0.254	4	1.016
No. of firm's innovation processes or patents per year	0.254	3.93	0.998
No. of R&D of firm's annual green technologies	0.254	3.98	1.011
No. of training hours for each employee	0.254	4.05	1.029

Within each green innovation measurement determinant, the performance measure with the highest score refers to the more dominant decision alternative that is most effective in contributing to measuring the firm's coping with such determinant. **Therefore**, based on the previous results, illustrated in the previous tables; 6, 7, 8 and 9, respectively**,** it can be concluded that the recommended decision alternative in terms of each of the green innovation measurement determinants can be presented as follows:

- Management innovation: product management and recycling mechanism, with the highest score of 1.081.
- Process innovation: waste reduction rate, with the highest score of 1.141.
- Product innovation: no. of customers' complaints, with the highest score of 1.113.
- Technological innovation: no. of training hours for each employee, with the highest score of 1.029.

13. Conclusion, Recommendations and Suggestions for Future Research:

13.1 Conclusion:

After the completion of this research study, the researcher has reached the following conclusions:

- Firms eventually mature and work towards coping with green initiatives that help to achieve sustainable development such as coping with green innovation, they also discover that depending primarily on conventional performance measurement systems are not suitable anymore. Thus, under the environment relevant for coping with green innovation, companies need to use new sort of measures that reflect green innovation's different aspects.
- EMA application can provide firms with the measures and information they need to foster green initiatives and enhance their environmental performance, which can in turn improve the value of the firm through improving its financial performance and enhancing its intangible value.
- Coping with green innovation and its aspects can be characterized as a set of processes and actions including: planning the transition to green development, identifying the necessary techniques and tools for coping with green innovation, determining the success factors and finally implementing green innovation and measuring the progress achieved towards coping with its different aspects. Thus, this new orientation begins with the identification of firm's objectives and then the linkage of such objectives to the suggested CSFs and performance measures, in order for them to be successfully achieved.

- Measuring performance of firms implementing green innovation should be taken into account comprehensively, because it should reflect the importance of strategic performance drivers. As SBSC provides an effective guide for a firm's core measures and enables the firm to customize its perspectives, in which sustainability measures are included, (learning and growth, internal business process, customers and financial perspectives), then, such perspectives help managers collect comprehensive information on the activities of measuring performance through using green thinking.

  This is because the SBSC is integrated into green innovation performance measurement framework and offers the capability to translate the firm's strategies into relevant activities and green innovation will offer the capability to influence such activities. For successfully measuring the performance of firm's activities with regards to green innovation, strategic performance measures and determined strategic objectives are matched together and constructed to measure the progress achieved in running the business according to plans and modifications. Further, the performance measures of the green innovation performance measurement framework based on SBSC are interrelated together in causal relationships by working through the SBSC perspectives in a sequential procedure beginning with the financial perspective.
- The proposed measurement framework was applied by the researcher in order to enhance the performance measurement system of Elaraby Group's washing machines factory by carrying out a case study to illustrate the applicability of the proposed framework.
- Consequently, the scoring model was utilized to indicate the relative importance of each criterion and also to determine the best decision alternative to recommend for the performance measurement framework of the factory.
- Based on the study's results, it is noted that the washing machines factory of Elaraby Group should place more emphasis on 'technological innovation' determinant as it has the most importance among other determinants for coping with green innovation. A business can potentially be able to successfully cope with green

innovation by adopting environmentally friendly technological advances because green technological innovation can be employed as a strategic tool to help create eco-friendly products and provide competitive advantages over other industry competitors. This necessitates that the performance measures ought to emphasize the measurement of the progress achieved by the firm in coping with green technological innovation.

- Further, the results showed that the performance measures with the greatest contribution to measuring the firm's progress in coping with each determinant of green innovation measurement were as follows:
  - Management innovation: product management and recycling mechanism.
  - Process innovation: waste reduction rate.
  - Product innovation: no. of customers' complaints.
  - Technological innovation: no. of training hours for each employee.
- Emphasizing such performance measures helps the firm to appropriately measure its progress in coping with each aspect of green innovation, which in turn helps to appropriately measure the environmental performance of the firm. This indeed can enable the firm to identify areas of weaknesses within its performance in adopting green initiatives in order to improve its environmental performance and succeed in standing out as a sustainable environmentally friendly business. Eventually, this will be reflected in a better image and an improved financial performance and value of the firm in the market.
- Therefore, the green innovation measurement framework proposed by this research based on SBSC can enable the factory to effectively measure and identify its performance gap within each of the green innovation measurement determinants in order to be enhanced and to achieve a comprehensive implementation of green innovation through successfully coping with its different aspects and in turn improve the environmental performance of the entire factory and this will positively affect its financial performance and its value among its competitors in the market.

13.2 Recommendations:

The researcher has offered some recommendations to the firms working towards coping with green innovation as follows:

First: These firms ought to depend on a system for measuring performance that reflects the aspects, objectives and determinants of green innovation environment in which performance measures are extracted by employing the SBSC approach and through merging the strategic objectives of the firm with the SBSC strategy map.

Second: By using the SBSC approach, the relevant green innovation performance measurement framework ought to translate the SBSC's four perspectives, in which sustainability measures are incorporated, (learning and growth, internal business process, customers and financial perspectives) into indicators which reflect the CSFs that are necessary to be accomplished under green innovation environment.

Third: Firms should attentively determine the relative importance of the performance measures that are stemmed from green innovation determinants and are created to promote the vision, mission and strategies of the firm.

13.3 Suggestions for Future Research:

The following issues has been suggested by the researcher for future research:

First: Future research may study the effect of the integration between green innovation practices and lean practices on the sustainable performance of firms. Also, future studies may emphasize all of the main pillars of sustainability; environmental, social and economic pillar, when utilizing the sustainability balanced scorecard instead of focusing mainly on the environmental pillar.

Second: Further research should be conducted in different sectors in order to empirically verify the proposed measurement framework.

Third: The scoring model relied on the judgements and perceptions of managers, engineers, employees, and workers of Elaraby Group's washing machines factory, which are thought to be more biased viewpoints. Future research can establish scoring models relying on the opinions of other stakeholders or employ models which are more objective as the Analytical Hierarchy Process (AHP) model, for instance.

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