African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 14 , Octobre 2022

Interactions between the Theory of Constraints and Sustainable Lean Management

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Déclaration de divulgation : L'auteur n'a pas connaissance de quelconque financement qui pourrait affecter l'objectivité de cette étude.

Conflit d'intérêts : L'auteur ne signale aucun conflit d'intérêts.

Pour citer cet article : KHIHEL .F & HARBAL .A (2022) « Interactions between the Theory of Constraints and Sustainable Lean Management» , African Scientific Journal « Volume 03, Numéro 14 » pp: 435-456.

Date de soumission : Aout 2022

Date de publication : Octobre 2022

DOI : 10.5281/zenodo.7299147

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 14 , Octobre 2022

Résumé

Les pratiques de développement durable restent aujourd'hui la préoccupation la plus controversée dans les processus de l'entreprise. En tant que tel, le concept de performance a été élevé au-delà des considérations économiques pour englober les multiples facettes de la durabilité. Cependant, la performance globale est un paradigme complexe puisqu'elle est liée aux parties prenantes, notamment les employés, les clients et les fournisseurs, et aux pratiques économiques, sociales et environnementales. Dans cet article, il s'agit de rassembler ces multiples parties prenantes et les variables de la responsabilité sociale des entreprises dans l'objectif d'en construire une vision stratégique où le Lean management est le pont central de la performance globale. En partant de l'hypothèse que les outils de Lean Management et les pratiques sociales et environnementales sont des variables correspondantes, nous supposons que l'interaction entre ces variables est vitale pour améliorer la performance des processus industriels. Nous avons basé notre méthodologie de recherche sur un échantillon de 107 entreprises marocaines industrielles pilotées par les trois dimensions de la durabilité, en se concentrant sur les contraintes majeures qui peuvent découler d'une telle combinaison. La théorie des contraintes est l'outil central pour identifier et analyser ces contraintes avec les ajustements possibles qui doivent être pris en considération. La qualification de ces contraintes repose sur leur capacité à satisfaire les objectifs stratégiques de performance tels que la qualité, le coût, le délai, la productivité et l'image de marque. Ces blocs sont les objectifs stratégiques visés par chaque entreprise pour réaliser une amélioration continue mettant l'accent sur le potentiel que les pratiques sociales et environnementales ont à offrir à la performance économique. Les principaux résultats montrent que la combinaison stratégique entre Lean Management et les variables sociales et environnementales est sujette à de multiples contraintes d'ordre principalement économique, qui nécessitent une étude d'impact préalable à l'instauration de toute démarche de soutenabilité à l'intérieur des processus de l'entreprise. Les outils du Lean Management sont certes générateurs de performance économique. Néanmoins, l'intégration d'objectifs sociaux et environnementaux peut nuire même aux objectifs de performance globale escomptée par l'entreprise. Il est alors nécessaire d'analyser l'impact entre les différentes variables et d'en optimiser les contraintes avant leur instauration. Ceci est l'objectif de cet article qui cherche à orienter la vision des entreprises sur les risques liés à une telle combinaison et de proposer des pistes d'ajustement et d'amélioration propres à chaque objectif stratégique.

Mots clés :

Lean management, Responsabilité sociale des entreprises, performance, théorie des contraintes.

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 14 , Octobre 2022

Abstract

Sustainable development practices remain today the most controversial concern of overall economic sectors. As such, the concept of performance has been leveled up beyond economic considerations to embrace multiple facets of sustainability. Though, global performance is a complex paradigm since it is related to stakeholders including employees, clients, and suppliers and to practices including economic, social, and environmental aspects. In this article, it is question of bringing together these multiple facets and variables in one platform where Lean Management and corporate social responsibility are the main strategic vision for enhancing global performance. Based on the hypothesis that Lean Management tools and social and environmental practices are correspondent variables, we suppose that the interaction between these variables is vital for more positive outcomes in industrial process. We based our research methodology in a sample of 107 Moroccan industrial companies driven by the three dimensions of sustainability, with a focus on the major constraints that can derive from such combination. The theory of constraints is the core tool to identify and analyse these constraints with the possible adjustments. The qualification of such constraints relies on their ability to satisfy performance strategic goals as quality, cost, time, productivity, and brand image. These groups remain the master goals aimed by every company to achieve continuous improvement with a focus on the potential that social and environmental practices have to offer to economic performance. The main results show that the strategic combination between Lean Management and social and environmental variables is subject to multiple constraints, mainly economic, This requires an impact assessment prior to the implementation of any sustainability approach within the company's processes. The tools of Lean Management are certainly generators of economic performance. Nevertheless, the integration of social and environmental objectives can even harm the overall performance objectives expected by the company. It is then necessary to analyse the impact between the different variables and to optimize their constraints before their introduction. This is the objective of this article, which seeks to guide companies' vision to the risks associated with such a combination and to propose ways of adjustment and improvement specific to each strategic objective.

Keywords

Lean management, corporate social responsibility, performance, theory of constraints.

AFRICAN SCIENTIFIC JOURNAL
MANAGEMENT AND ECONOMIC DEVELOPMENT

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 14 , Octobre 2022

Introduction

Considering sustainable development appeals to engage industrial processes in a more respectful vision of environment and people, companies are today more responsible for the way they make profit. This profit that defines performance is not sufficient to assess the implication degree in sustainable goals. There are more paradigms that testify this performance[1] through social and environmental performance indicators. Hence, companies with different sizes and sectors should engage in actions and practices that respond better to their goals and to demands of their stakeholders without harming the final goal which is financial. If many practices demand investments and efforts, their return on investment is the playing card to justify these practices inside processes. Despite such assumption, calculating this return on investment is most of the times hard and confusing. Quality, cost, time, productivity, and brand image are strategic goals but very complex and difficult to manage even when only economic performance is implied. If adding social and environmental practices is a label for companies, multiple constraints can emerge while integrating them inside workflows. Therefore, studying the principal tools of Lean Management and the main allied practices is a difficult task regarding market uncertainty and the nature of operational platforms used to produce and satisfy clients. In the case of Lean Management, tools and principles are so rigid that irregularity is not allowed[2]. Adding other forms of irregularity through social and environmental practices can be source of issues and adjustments inside Lean processes. Therefore, the aim of this article is to identify the kind of sustainable practices that generate less constraints while linked with Lean tools. Furthermore, we will present some key adjustments as general guidelines to consider while composing these variables. The theory of Constraints has been chosen for its ability to scan and resolve constraints[3] even though in the case of Lean Management, the constraints are from different natures than the scope of TOC. We will answer the main hypothesis that addresses following:

Hypothesis: Lean Management tools and social and environmental practices are correspondent variables.

[1] Kaplan R.S. and Norton D.P. (1996b), The Balanced Scorecard: Translating Strategy into Action, Boston, MA., Harvard Business School Press.
[2] Liker, J., 2004. The Toyota Way, McGraw-Hill
[3] Goldratt, E.M. (1990), What is this thing called the Theory of Constraints? North River Press, Croton-on-Hudson, NY,

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To answer this hypothesis, we rely on the following research methodology:

Methodology:

To be able to address this hypothesis, we chose to study a sample of 107 Moroccan industrial companies in which 50% are already implementing Lean management tools, and social and environmental practices. The study is based on the following structure:

- The exploration of potential alliances between tools and practices,
- The categorization of these alliances into positive and negative alliances,
- The selection of positive variables alliances by strategic objectives which are: quality, time, productivity, cost, and brand image,
- The extraction of main constraints driven by these negative alliances,
- Adjustment suggestions to decrease the impact of these alliances.

The main instrument used for such variables study is the theory of constraints along with Lean management « JAT » principle. The main philosophical approach to such instrumentation is to construct a new paradigm of how companies can reflect their sustainable issues while engaging in a sustainable vision.

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1. Littérature review :

1.1 The Theory of Constraints

The Theory of Constraints (TOC) was developed by Dr. Eliyahu Goldratt[4] and was introduced in his book "The Goal." Goldratt suggested that organizations can achieve their goals by identifying and leveraging a system's constraints. A constraint is something that limits performance, and this theory assumes that there is always at least one constraint, if not more. It has been split into five key steps:

1. Identify the constraint,
2. Exploit the constraint,
3. Subordinate everything else to the constraint,
4. Elevate the constraint,
5. Avoid inertia and repeat the process.

In this context, we can suggest that a constraint is any element that has an impact on reducing profit or will have an impact improving it. Hence, a constraint can be either tangible (identified as a performance inhibitor) or can be found by managers through their research of more added value while analysing processes. We can assume that TOC is a continuous improvement method that can be applied in every aspect of an organization: processes, employees, machines, methods, etc.…This has led Goldratt to identify two main types of constraints: a material constraint is typically related to employees and machines, and a political constraint (or immaterial) related to methods and procedures. With this being clarified, the "Theory of Constraints" is extremely practical in that it helps find simple, effective solutions to real-world problems. Hence, in applying this theory in sustainable development can have many benefits for companies to embrace social and environmental variables in processes.

1.2 Lean Management

Another important aspect of continuous improvement is the Lean Management philosophy that was developed by the Toyota production system and baptized as such by Womack and Jones[5]. This approach was defined by Taiichi Ohno, a prominent engineer in the Toyota firm by the following: "All we are doing is looking at the timeline, from the moment the customer gives us

[4] Goldratt. E. (1984). "The Goal: A Process of Ongoing Improvement."

[5] Womack, J.P., Jones., Roos. D. (2007). The machine that changed the world

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an order to the point when we collect the cash. And we are reducing the timeline by reducing the non-value adding wastes." [6]

Ohno's theory was that wastefulness and inefficiency were the reasons why Toyota's production was lagging so far behind. Therefore, he made it his personal mission to eliminate inefficiency and waste in production that was his responsibility. These concepts helped to form the core principles of what later became known as the Toyota Production System (TPS) when it was fully developed by Ohno and several others during the 30 years after World War II. There are few parts of this system that are frequently used in the United States: for example, Kanban (the tags that are used in a just-in-time stock control system), Jidoka (the injection of quality) and Muda (waste elimination). However, this method has been criticized by its strictness and rigidity in reshaping processes as being perfectly performing a continuous added value by allowing side effects such as stress and interactional conflicts between teams and managers. Another critic has been addressed which is the environmental aspect that can be shadowed to maintain the total quality concept, called the quality/environment dilemma[7]. This leads to consider that while implementing Lean manufacturing tools many constraints will emerge making the sustainable Lean aspect a more complex theory to embrace.

2. Sustainable Lean Management

While implementing lean manufacturing tools, many social and environmental aspects can be driven by organization as being set up by the method itself. Some of the main sustainable components lead by Lean Manufacturing are called the two pillars of Lean: Waste chase and People's respect[8].

2.1 Environmental practices and Lean Management

The first pillar is related to 7 key causes of waste, which can be directly related to environment. Therefore, eliminating them is a way to minimize their impact in the environment as shown by the table above:

[6] Ohno, T. (1988). The Toyota Production System: Beyond Large-scale Production, Productivity Press
[7] Liker, J., Morgan J. (2006). The Toyota Product Development System, Productivity Press
[8] Liker, J., Meier, D. (2007). Toyota Talent, McGraw Hill

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Table N° 1: core waste categories by Lean Management

MUDA type	Impact on waste reduction
Inventory	This principle allows the reduction of oboslete material of any nature: - Deteriorated raw material ; - Final and semi final deteriorated products. - Packaging products, preservation and conditioning material. - Physical installations, machines, and tools. - Cleaning Materials.
Unuseful process	Unuseful process generate unuseful physical and information such as administrative records and additional machines and tools.
Unuseful physical traffic	- Information and communication tools enable the reduction of physical traffic inside the workplace.
Defects	Defects are the result of production errors that generate adjustments and reforms, sometimes these products can't be repaired which generates more waste.
Unuseful mouvements	Eliminating unnecessary mouvements allows to reduce accidents risks of and material and tools false manipulation.
Overproduction	Overproduction generates additional inventory and potential accidents and products deterioration.
Underusing skills	Neglecting employees' ideas and suggestions can be a relevant cause for potential solutions and improvement loss.

Source: Elaborated based on (Hansen, J., T. Bond, B. Cairns, H. Gaeggler, B. Liepert, T. Novakov, and B. Schichtel, (2004). Carbonaceous aerosols in the industrial era. Eos Trans. Amer. Geophys. Union, 85, no. 25, pp: 241, 245).

However, the principles of Lean Management based on « the just in time » tool can be widely a cause of damaging the potential objectives of waste reduction and though to environmental improvement as illustrated in the figure below:

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ISSN : 2658-9311
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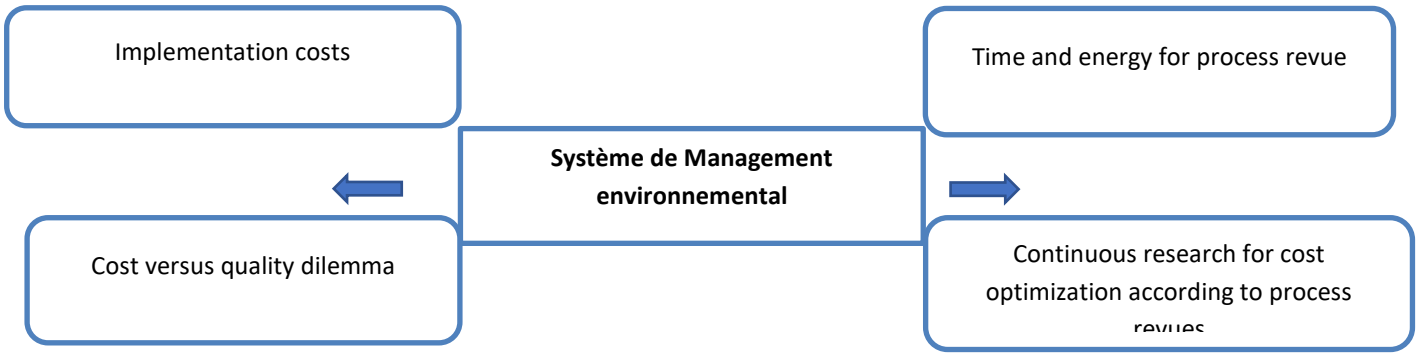
Figure N° 1: Negative impacts of environmental practices on firms' performance



Source: Elaborated by us

For Venkat and al.[9], implementing environmental practices can be source of great dilemma. For example, in a JAT process, reducing Carbone dioxide emissions is problematic due to frequent transportation traffic implied by the principle itself. When cold conditioning is necessary for a production line, dioxide emissions depend largely on the transportation conditions and the distance of final delivery. When distance is large, the number of emissions is less compared to short distance. Whereas, when cold conditioning compulsory, the reduction of inventory is induced which makes delivery process more frequent and therefore generates more emissions. Another observation related to the surface area where deliveries are operated. If the surface is small, deliveries are more frequent but not with a long distance allowing less emissions and less cold conditioning. However, if we state that the supply chain of small regions is green, there is another issue because the implementation of Environmental Management Systems can be problematic because of products maintenance operations being more frequently used which means more chemical products and health problems. This constraint has been addressed by Frits and Rothenberg[10] who bring the idea that using more water, more electricity, energy, and maintenance products generating obvious impacts on environment and health. These authors address the question that firms in this case must be able to answer the following question: resources preservation or quality improvement? The solution to this dilemma is the presence of environmental solutions to quality problems. They suggest that firms enable quality problems

[9] Venkat, K., Wakeland, W. (2006). Is Lean Necessarily Green?", Systems Science Faculty Publications and Presentations. Proceedings of the 50th Annual Meeting of the ISSS, Sonoma, CA, 17

[10] Frits, K.P., Rothenberg, S. (2009), "Environmental performance as a driver of superior quality ». Production and operation Management, https://doi.org/10.1111/j.1937-5956.2003.tb00211

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to emerge to come up with environmental solutions. Other authors such as Porter et Linde[11] et Shrivastava[12], Beechner et Koch[13], brought the hypothesis that certain environmental improvements can increase costs. For Venkat et al.[14], supply chains based on Lean management don't reduce necessary dioxide emissions especially when delivery distance is large.

2.2 Social practices and Lean management

The second pillar which is related to people's respect is related to every form of minimizing, overusing, or down using people's potential at realizing tasks caused by inefficient management, or even between employees themselves. We add to these factors, the potential impacts of tools to engage stress, conflicts and misunderstanding while operating in processes. The following table demonstrates how Lean manufacturing tools can be harmful for employees and processes while performing economic improvements:

[11] Porter, M. E., Linde, C. V.D. (1995), "Toward a New Conception of the Environment-Competitiveness Relationship". Journal of Economic Perspective, vol. 9, n° 4, pp: 97-118.

[12] Shrivastava, P. (1995). Environmental technologies and competitive advantage". Volume16, IssueS1 , Special Issue: Special Issue, pp:183-200

[13] Beechner, A.B., Koch, J. (1997). "Integrating ISO 9001 and ISO 14001". Quality Progress, 30 2, pp: 33–36.

[14] Venkat, K., Wakeland, W. (2006). "Is Lean Necessarily Green?". Systems Science Faculty Publications and Presentations, Proceedings of the 50th Annual Meeting of the ISSS, Sonoma, CA, p. 17.

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Table N° 2: Negative impacts of social performance

Outils/principes	Negative impacts of social performance
Equipment reconciliation	- Noise and auditive issues ;
Unnecessary JAT[15]	- Stress and accidents risk due to JAT production and deliveries.
Unnecessary SMED	- Stress due to frequent die exchange implying more polyvalence and flexibility by employees.
Unnecessary JIDOKA	- JIDOKA is a strict method that implies a standardization of process practices. These conditions generate stress and demand more energy.
Unnecessary shifts	- Work densification and less formal exchange. - Less resting and muscles problems with psycho-social impacts.
Versatility	- Operators overwork (INRS (2015))[16]
Lots size reduction and Unnecessary process	- Tasks' ambiguity (Hasle et Bojesen (2012))[17]
Perfection research	- Multiple testings and controls (Hasle et Bojesen (2012))[18]
Team spirit	- Frequent tasks changes, frequent teams' reorganization (Conti, et al. (2006))[19] ; - Absent employees task affiliation, employees, and management conflicts (Hasle et Bojesen (2012))[20] ; Competition mindset (INRS (2015))[21].

Source: Compilation from cited authors

Social negative impacts illustrated in the table below especially those related to conflicts and stress should be addressed by managers even before implementing Lean tools, in order to minimize their outcomes on performance results. Solutions can be based on team rotation around tasks. The specialization is a Lean principle standard but should be applied on a diversity of tasks. This allows employees to skip routine burden and therefore rotate around different tasks to gain more skills and knowledge in the processes. Here, we can assume that specialization and knowledge transfer should be driven together as a potential way to overcome

[15] Institut National de Recherche en Santé (2015). « Lean Manufacturing, quelle place pour la santé et la sécurité au travail ? », INRS, p. 75.
[16] Idem, 125.
[17] Hasle, P., Bojesen, A. (2012). "Lean and the working environment: A review of the literature". International Journal of Operations & Production Management 32(7), pp:829-849

[18]Idem, 157.

[19] Conti, R. Angelis, J., Copoper, C. (2006). "The Effects of Lean Production on Worker Stress". International Journal of Operations & Production Management 26(9)

[20] Hasle, P., Bojesen, A. (2012). "Lean and the working environment: A review of the literature". International Journal of Operations & Production Management 32(7), pp :829-849

[21]Institut National de Recherche en Santé, Lean Manufacturing, (2015). « Quelle place pour la santé et la sécurité au travail ? ». INRS, 2015, p. 75.

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employees' frustration and stress. As we have seen in the environmental negative impacts of Lean tools, the solutions differ since the nature of constraints occur not only due to human resources management but mainly to the way environmental practices are intended to be used for performance improvement. This implies that adjustments and solutions are calculated according to the optimal performance goal. The theory of constraints is a useful instrument for such constraints, and therefore can be categorized whether they are from material reasons (employees and machines) or political reasons (methods and tools).

3. Theory of constraints in optimizing sustainable lean management constraints

While Lean manufacturing tools and principles can be a source of efficiency in optimizing resources and creating value, their potential risks must be defined and managed in coalition with the firms' goals to attend the corporate sustainable development approach. The TOC can be one of the main methods to manage these constraints whether they subscribe as material constraints or political constraints. As defined by Goldratt. These constraints must earn large attention as being opportunities to level up performance and especially the economic one, in the meantime by implementing the range of social and environmental practices that can lead firms to stakeholders' interest. The reflection of Freeman22 in bringing the 'Stakeholders theory » is mainly related to the firm being wise in making value more sharable by individuals impacted by the firms' activities. The definition of stakeholders is clear "The basic idea is that businesses, and the executives who manage them, actually do and should create value for customers, suppliers, employees, communities, and financiers (or shareholders)." [23] and hence constraints must be resolved or at least minimized by taking into consideration the full impact of these constraints to the best profitability scenario for all stakeholders. Hereby, the following table addresses the potential constraints to be minimized by firms while implementing lean manufacturing tools:

[22] Jones, T.M., Wicks,A.C., Freeman, R. E., (2017). Stakeholders Theory: a state of the art. https://doi.org/10.1002/9781405164771.ch1
[23] Bidhan, P. L.; Freeman, E., Harrison; j., S. (2010). "Stakeholder Theory: The State of the Art". Management Faculty Publications. 99. https://scholarship.richmond.edu/management-faculty-publications/99

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Tableau N° 3: Similarities and differences between JAT and TOC

Aspect	Similarities	Just in Time	Constraints theory
General focus	Continuons improvement, Total quality, minimum inventory.	Global focus on processes.	Global focus on contraints
System and Methods	Pull system and material control method.	Using Kanban as a material trigger mean of previous station.	Drum-buffer-rope is used as a material from the first station.
Inventory	Over inventory is considered as a type of waste.	0 inventory is the aim.	Buffered inventory is necessary for constraints adjustment.
Global objectives	Firm's profile improvement.	Reducing costs by reducing waste and implementing the principle of « People respect ».	Profit gain in the court and long terms.
Implementation equilibrium		Implementing balanced measures that can be used in all stations.	Implementing an imbalanced measure in a station in order to adjust the constraint.
Lot size	Small lots, with the possibility of transfer without size consideration.	Process and lots transfer equity.	Sizes difference is allowed.

Source: Nave, D. (2002), "How to Compare Six Sigma, Lean and the Theory of Constraints A framework for choosing what's best for your organization". Quality progress, American Society for Quality, Polito, T., Watson, K. (2006), Just in time under fire: the five major constraints upon JIT practices, The Journal of American Academy of Business, Cambridge, vol. 9 Num 1, 7 pp: 6.

To sum up table 3 information, we observe that both methods allow the following:

- 0 inventory (best situation),
- Inventory costs reduction related to inventory maintenance,
- Transports reduction,
- Carbone dioxyde reduction in process,
- Employees skills improvement,
- Agile response to commands,
- Minimizing or reducing JAT constraints through TOC.

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These observations help address the list of constraints to be managed in a JAT platform as presented in the following section.

4. Exploratory study for hypothesis answer:

While literature review served as a theoretical base for social and environmental actions outcomes in the scope of performance, assessing them in a tangible base is a compulsory exercise for every process and activity. That's why we chose to study the foundation of such implementation in Moroccan industry. Our research used a sample of 107 industrial companies with the potential to implement Lean tools or not. The sample characteristics seek to prove how interactions between multiple Lean, social and environmental variables influence the way performance is driven.

4.1 Exploratory study

To assess the main constraints related to Lean management practices and to be able to address the main hypothesis: ***Lean Management tools and social and environmental practices are correspondent variables,*** we used a sample of 107 Moroccan industrial firms located in the Region of Casablanca-Settat. 57% of these companies are implementing Lean practices and tools in addition to social and environmental practices. The integration of sustainable development practices has indeed generated several issues for which companies often have to struggle between maintaining the Lean tool and pairing it to the social and environmental practices. This impairment is a source of different types of constraints. Table 4 addresses the characteristics of the sample and the nature of constraints:

Table N° 4: Study sample characteristics

	Size	**Sectors**
Sample characteristics	- The main sample used contains 200 companies from which 107 companies responded (nearly 53% as rate response). - 50% of the 107 companies are indeed implementing Lean tools and sustainable practices.	- Automotive industry - Aeronautic industry - Plastic industry - Electric and electronic industry
	Instruments	**Variables analysis**
Survey characteristics	Questionnaire driven by emails and phone calls.	The analysis has been conducted through SPSS tool.

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The questionnaire distributed to companies has shown that when companies implement sustainable development practices in alliance with a Lean platform, another process is compulsory. This process is the adjustment process of potential constraints sufficient to make performance objectives rather difficult to attend. Table 5 is a summary of these constraints depicted by types of strategic goals as: quality, productivity, time, cost, and image.

Table N° 5: JAT constraints and related practices and performance indicators

Related constraints	Sustainable development practices related to quality improvement
Quality[24]: ○ Difficulty maintaining process quality, ○ Quality research can be source of environmental impacts. ○ Process that are not well studied can demand more maintenance and products use which leads to more environmental impacts. ○ Matrial content changes such as water quantity, solvent, painting quality can diminish the quality of the painting.	○ Standardization ; ○ Kaizen ; ○ Process Design / Redesign; ○ Poka-Yoké ; ○ Quality standards and certifications ; ○ VSM ; ○ Statistic Process mastering ; ○ Jidoka ; ○ Go and see (Gensu Gembutsu); ○ Defaults elimination (MUDA) ; ○ Ishikawa ; ○ 5 S ; ○ Environmental certification ; ○ Environment innovation ; ○ Claims management ; ○ Market studies ; ○ Products conception ; ○ Social needs satisfaction ; ○ Emplyment creation ; ○ Knowledge development and transfer ; ○ Training ; ○ Scientific and technological transfer ; ○ Supply Chain partnership.
Cost[25] ○ Social and environmental practices bring companies to provide investments. The major constraints is the calculate the return on	○ U work cells; ○ Inventory reduction ; ○ Pull system ; ○ Kanban ; ○ Standardization ; ○ Process Design / Redesign ;

[24] Shah, R., & Ward, P. (2007). Defining and developing measures of lean production.

[25] Smith, A. (2020), Adapting Lean methods to facilitate stakeholder engagement and co-design in healthcare.

Published online 2020 Jan 28. doi: 10.1136/bmj.m35

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investment. Such calculations allow managers to prove the returning profit coming from such investments.	○ Total Productive Maintenance ; ○ Jidoka ; ○ Flux pièce à pièce ; ○ Overproduction elimination; ○ Defaults elimination ; ○ Inventory elimination ; ○ Unuseful process elimination ; ○ Unuseful deplacement elimination ; ○ Unuseful transports elimination ; ○ Safety policyy ; ○ Work medical services ; ○ Gestion des Réclamations des consommateurs ; ○ Market studies ; ○ Products conception ; ○ Consumers interests ; ○ Social needs satisfaction ; ○ Fair prices ; ○ Social investments ; ○ Community relationships ; ○ Communication ; ○ Knowledge development ; ○ Kbowledge transfer ; ○ Training ; ○ Scientific and technological innovation ; ○ Work conditions ; ○ Supply Chain partnerships ; ○ Droits de l'homme ; ○ Energetic efficiency ; ○ Industrial waste elimination; ○ Environmental quality ; ○ Recycling ; ○ reemployment; ○ recycled material reuse ○ competitive advantage
Time[26]: ○ The reduction of inventories can be source of multiple problems: ○ Non-respect of deliveries ; ○ Long delivery delays ; ○ Clients unsatisfaction ; ○ Clients withdrawal. ○ SMED is a time-consuming tool due to	○ Lot size reduction ; ○ Continuous flows ; ○ SMED ; ○ Poka-Yoké ; ○ Takt time ; ○ Total Productive Maintenance ; ○ Jidoka ; ○ Waiting time reduction ; ○ Agility ; ○ Information system ;

[26] Shaturaev, J. (2021), transformation of business efficiency with the Lean management, German international journal of modern science n° 22, pp: 34-42.

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frequent changes and maintenance.	○ Partenariats entreprise/fournisseurs ; ○ « Takt Time » ; ○ VSM ; ○ Process Design/Redesign ○ Innovation ; ○ Learning enterprise ; ○ Market studiesé ; ○ Products Conception ; ○ Consumers interests ; ○ Social needs satisfaction ; ○ Employement creation ; ○ Knolwledge development and transfer ; ○ Training ; ○ Environmental and social surveys
Productivity[27] ○ SMED is a stressful tool. ○ The principle of gathering equipments related to same process can be source of noise and auditive issues. ○ The « U » line limits employees' movements and generates less communication exchange.	○ Lot size reduction ; ○ SMED ; ○ Poka-Yoké ; ○ Total Productive Maintenance ; ○ Waiting time reduction ; ○ Partenariats entreprise/fournisseurs ; ○ Process Design/Redesign ○ Innovation ; ○ Market studies ; ○ Products Conception ; ○ Consumers interests ; ○ Social needs satisfaction ; ○ Employement creation ; ○ Knolwledge development and transfer ; ○ Training ; ○ Environmental and social surveys
Brand image[28]**:** ○ Multiple social and environmental Investments ; ○ The permanent research of ethical suppliers. ○ Difficulty procuring best quality material and products from certain markets especially those known by lack of engagement in sustainable	○ Learning enterprise ; ○ Employees respect ; ○ Coaching ; ○ Motivation ; ○ Environmental Management System ; ○ Carbone dioxyde reduction ; ○ Waste elimination ; ○ Gestion des Réclamations des consommateurs ; ○ Market studies ; ○ Products conception ; ○ Consumers interests ; ○ Social needs satisfaction ; ○ Fair prices ;

[27] Eaton, K.J. and Amato, A. (2005). A comparative environmental lifecycle assessment of modern office buildings. The Steel Construction Institute. ISBN 1 85942 0583

[28] Gadde, L.-E., & Dubois, A. (2002). The construction industry as a loosely coupled system: implications for productivity and innovation. Construction Management and Economics, pp. 621-631.

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development practices (the example of China), ○ The brand image can be vanished due to the minimum errors that can impact reputation largely in the market,	○ Social investments ○ Community relationships ; ○ Communication ; ○ Knowledge development and transfer ; ○ Local media relationships ; ○ Educational programs ; ○ Scientific and technological transfer ; ○ Work conditions ; ○ Philanthropy ; ○ Conflicts management ; ○ Supply Chain relationships ; ○ Anti-corruption practices ; ○ Anti-competition practices ; ○ Droits de l'homme ; ○ Droits de l'enfant ; ○ Equity ; ○ Social awards ; ○ SME ; ○ Carbone dioxyde reduction ○ Waste elimination ; ○ Environmental innovation certification.

Source : Exploratory study findings

From Lean, social, and environmental variables interactions, we understand that sustainable variables do not permanently coordinate. They rather create a variety of results depending on how they are implemented. Political constraints[29] which are related to implementation methodology, have strong effects on performance. Many adjustments can be made even before the implementation process if management and information emphasis on bringing together the positive scenarios and identify potential negative impacts of tools and sustainable practices. The way Lean management is implemented is a great value since not all tools and practices can be applied at once. Furthermore, applying tools and practices could be solutions for previous constraints rather than being the constraints. In the following section, we intend to suggest some key constraints adjustments by types of goals and performances.

4.2 Ajustement suggestions :

To adjust the constraints presented by the combination of Lean Management and social and environmental practices, we suggest some adjustments that can be taken into consideration by companies while implementing these practices.

[29] Goldratt. E., in his 1984 publication, "The Goal: A Process of Ongoing Improvement."

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Table N° 6: Sustainable Lean Adjustment suggestions

Strategic goal	Adjustment suggestions
Quality	The constraint linked to the choice between quality and environmental quality can be solved by allowing quality problems to emerge and finding environmental solutions to them.
Cost	« Life Cycle Cost » and « Life Cycle Analysis » are two tools that depict each stage and process's cots to optimize them. Coupled to Value Stream Mapping (VSM), these tools are relevant instruments to help reduce costs.
Time	Reliability analysis in terms of commands forecast allows companies to be agile in periods of maximum commands. The information system managing these commands should allow these calculations to be nearly precise. Material resource planning is a calculation tool for such forecasts even in JAT process.
Productivity	SMED and POKE YOKE are compulsory in the production process in a Lean platform but can be source of stress and conflicts. Teams should be rotated through different lines and tasks to be able to operate in different processes. This can absorb the amount of stress implied by these tools.
Brand image	Brand image should be well analyzed in terms of strategic goals intended by companies. A company can focus on one strategic role such as attending a client's niche by enhancing and communicating an image aspect. It aims to inform the clients in order to attract that niche.

4.3 Results discussion

Methodology reminder :

In this article, we intended to analyse the interaction between Lean variables and social and environmental variables to improve companies' performance. We based our findings in a sample of 107 industrial Moroccan companies by studying their Lean and sustainable practices. The survey tool is a questionnaire that has been administered through emails and phone calls.

Hypothesis answer:

Hypothesis: Lean Management tools and social and environmental practices are correspondent variables.

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By studying the impact of social, environmental, and Lean variables on each other, we observed multiple constraints emerging by such Lean sustainable strategic alliance. The JAT coupled with the TOC can be an important strategic tool to help minimize such constraints and improve the impact of these practices on performance. We assume by this study the following findings :

- Lean manufacturing tools and social and environmental practices are complexe variables interacting in one platform.
- Not all Lean tools can be coupled with social and environmental practices and vice versa.
- Companies should define the overall constraints while implementing Lean tools with sustainable practices.
- In implementing Lean tools, companies should use different statistics and calculation instruments such as « Life Cycle Cost » and « Life Cycle Analysis » to predict the best scenario.
- The implementation scenarios should focus on implementation strategic objectives as : quality, cost, time, productivity and brand image.
- The TOC can help resolve these constraints even if they are from different natures (social and environmental issues) in a Lean platform.

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Conclusion

The goal of this article is to depict the links between Lean Management and social and environmental practices. The methodology has been based on the study of potential positive and negative alliances between these concepts with a large focus on problematic alliances. The negative alliances can cause companies to abort the strategic vision of integrating sustainable development when their master goal is to create profit. Hence, alliances that are problematic will drive to quit investments toward such practices. On the other side, not integrating these practices can lower their image and credibility toward clients and potential partners. The issue is more prone to develop in a Lean management platform, initially destinated to improve performance. In such case, social and environmental practices are the main concern to bring all together the operational and the sustainable excellence. Our research intended to extract these negative impacts emerging by Lean management and sustainable practices, and then apply the theory of constraints to adjust them. The use of such theory is a relevant choice since this theory can compass the strategic direction of companies when implementing practices. Indeed, we observed that not all Lean tools can be linked to social and environmental practices. Many of them such as SMED, Poke Yoke and Kanban can be source of great amount of stress, furthermore some practices such as Environmental Management System are not always in adequacy with quality, but rather can decrease it if tools are used strictly to enhance economic performance. Many statistic tools can be used to optimize the choice of Lean tools and the best matching tools such as « Life Cycle Analysis » and « Cycle Cost Analysis » and drive companies to forecast the most optimizing scenario before pointing social and environmental practices. To attend this, companies should have invested in implementing information systems that analyse every single data related to process. The Value Stream Mapping (VSM) as a Lean tool can fill this gap by using it as a permanent informational tool in a linked electronic system. In the industrial Moroccan context, all companies can be ready to attend this high level of information but should be aware of the importance of implementing only relevant Lean tools and practices by engaging expertise and knowledge among their employees. The role of training and knowledge transfer is a great principle in which the whole philosophy of Lean management relies.

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