The Sustainability Bet: Eco-Project Management

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Abstract

The ‹sustainability› is becoming recurrent concern, but the real terms of the impending facts are not yet fully acknowledged. In the note, the analysis focuses on the supporting technologies, even if the backdrop situation is necessarily mentioned to define the scenario. The exploration outlines the ecology related results recently discussed in a series of studies, by the authors.

Keywords: Product Lifecycle Management; Product-Service; Extended Enterprise; Sustainable Corporation; Ambient Intelligence

1. Introduction

The ‹sustainability› is magic trait, which allows increasing the spendable riches, with no or little harmful effects on the eco-system and other individuals, over the pre-set considered period. This achievement is enabled by the human ‹progress› myth, which mixes tangibles and intangibles, creating value-added by conveniently exploring ‹life› and ‹intelligence› processes. In the material reality, ‹entropy› enjoys well acclaimed worth, leading to assed downgrading. In the spiritual reality, when using dualism epitomes, the situations include: lifecycle growth, with inner agentive headway, moving outside the entropy decay; and human decision-making, with rational choices, selecting improvements and rejecting drawbacks. Indeed, growing is distinctive feature of the living beings, to reach the fully developed stage, before decaying and death. In nature, there is no perennial increasing (and entropy downgrading is

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fully gauged). Only *brainpower* is the added chance, with knowledge enabling virtues, in the spheres of abstract logic and intellectual reasoning: civilisation opposes to wilderness, once mind worlds are priced.

‹Sustainability› is, possibly, illusion, replacing the one-century old ‹excelsior› allegory, when the industry revolution was thought providing wealth at human planned extent, by controlled artificial energy sources. The over-depletion/pollution issues, compared to the *natural* recovery/rescue potentials, show that the earth decay is non-stop occurrence. ‹Sustainability›, thus, is interpreted to embody the monitoring of the falloff and the management of the on-duty supply chains: the objective avail of special purpose aids, PLM, *product lifecycle management*, SE, *service engineering*, RL, *reverse logistics*, and related links, to assemble data and to modify burning up and toxic waste end effects, by appropriate controls, Fig. 1, through models and metrics [1].

- **open complex product representation**: to build standards and procedures that enable creating a reference model to yield complete descriptions by simple modules addition and interoperability methods;
- **robust performance simulation environment**: to fashion courses translating customers’ needs and wants, and tracking the cost sensitivity along the value chains, by means of plug-and-play blocks;
- **flexible integral process representation**: to specify the manufacturing capacity/capability layout, including options, such as productive break-up and out-sourcing;
- **conformance assessment simulation environment**: to validate the on-process functional requirements, impact prescriptions, amount of material reclamation, etc.;
- **stretchy primary lifecycle representation**: to describe the supplier responsibility and the service sold with the product (reprocessing and recycling included);
- **eco-consistency assessment environment**: to define the third-party certification bodies and the reference metrics, related with the supply chain eco-impact;
- **distributed supply chain collaboration environment**: to provide the features of the networked organisation, linking suppliers, consumers and controllers.

Fig. 1. Main goals and requirements in the supply chain control.

On these facts, several research programmes have been devised, aimed at *natural capital* bookkeeping: if it focuses *consumerism* imbalance, right warning follows, since: ‹forewarned, forearmed›. The prosperity is likewise assessed, explicitly showing the amounts obtained by resource outgoings, compared to the one given by plain value-added supplied by artificial man activity. The *affluent society* cannot be said reliable or morally neutral. *Economic* attainments need to be weighed against *ecologic* damages. Today *prosperity* has to be projected in tomorrow caused decay. *Sustainable growth* means programming the *affluence* rate and extent, in function of the *natural capital*, by means of standard precepts [1,2], i.e.:

- to lower non-renewable resource depletion, with higher natural capital productivity
- to invent new useful stocks, by cognitive patterns with restoration/remediation jobs

The present survey goes around recently developed topics, purposely outlining the basic prerequisites of the implementations, through hints about the conditioning innovations [3,4]:

- integrated design, supporting the engineering knowledge frames
- product-service delivery, covering lifecycle/reverse logistics tasks
- adequate ‹sustainable› corporation employment and management

The developments avail of results of past research activities, basically, quoted by the listed references, in view of emphasizing not avoidable impending challenges.

2. The Design Frame of ‹Sustainability›

The eco-protection is entrepreneurial challenge, which moves from the *simultaneous engineering* design of products-and-processes, to the environment-and-enterprise reworking along the lifecycle supply chain by concurrent net-concern editions, Fig. 2. The emerging business patterns profit of cooperative networked organisations, according
to alternative approaches [5,6,7]:

- **extended enterprise**, unifying manufacturing, service and reverse logistics
- **virtual enterprise**, fitting organisation of the needed facilities and functions

Both approaches require focusing on the *design features*, moving the business profitability to be mainly dependent on the initial choices of the prospected supply chain. The first shall include «function» delivery, with lifecycle servicing, recycling/recovery abilities and certification fixing. The second has to manage given manufacture «facilities», integrated in the lifecycle/end-of-life supply chain «utilities» [8,9,10].

![Fig. 2. Main steps and opportunities of the eco-partnership.](image)

The partnership competitiveness moves from the capability of offering new products (fit-for-purpose to *individual* needs), to the ability of providing services, granting the expected functions to proper satisfaction and better tangibles effectiveness (fit-for-purpose to *general* paybacks). The Figure 3 collects practical hints on addressing suited technical requests. The business benefits of knowledge-driven efficiency, spending *total connectedness*, notably, when dealing with a net-concern, built by independent companies, which focus on their core competencies, joining the efforts for co-design, co-manufacture, co-marketing, co-maintain, co-servicing and co-recycle, in view to satisfy the requirements of supplying *products-services*, at the clients’ advantage and environment safety [11,12,13].

![Fig. 3. Main steps and opportunities of the eco-partnership.](image)

The knowledge build-up has particular relevance; the design of *products-services* aims at sets of *special-purpose* scopes, so that each choice helps achieving optimal technical and eco-consistency rules, yielding:

- cooperation ways, binding actors on lifecycle (e.g., for fair ‘transmission’ of economic incentives)
- beforehand combined users’ requirements, pre-emptively designing duty-driven answers for them
- delivery characteristics, attuned to the existing level of equipment (modular design could help)
- establishments for parts and products temporary or final call-back, focused on efficient transfers
- expanded options of the provision enjoyment, foreseen with included client’s information sheets
- marketing strategies, with included clients’ education about the most appropriate delivery use
- advertising plans, promoting the environmentally more acceptable way of function completion

- **product-process-environment-enterprise**: the externalities role;
- **knowledge-driven paradigms**: cooperative net-concern actions;
- **lifecycle product design**: green-engineering conservativeness;
- **service engineering & ambient intelligence**: intended contracts;
- **reverse logistics**: recovery/remanufacturing enhancing targets;
- **facility/function market**: agility by virtual enterprise integration.

- **product-service unified data-frame**: the delivery of extended artefacts is primary business achievement, and lifecycle knowledge is basic requirement, since the earlier design steps;
- **integrated data-flow management**: hierarchical, interconnected, parametric product and business models ensure that decisions are right away made, achieving entrepreneurship-wide impact;
- **distributed, flexible operability**: robust communication and shared data-base joined to processing resources help establishing teaming relationships, to face every emerging requests;
- **plug-and-play interoperability**: all technical and business modules need be seamlessly compatible and self-adapting, to become operational immediately, without integration cost;
- **total connectedness**: all acknowledged actors are linked by communication infrastructures that deliver the right data at the right time, whenever they are required;
- **fully enabled extended artefact transparency**: the PLM tool, linked to proper science-based and experience-driven knowledge, grants visibility to decision schemes and achieved performance.
• the disposal and recovery duties, optimising productivity of the engaged resources; and so forth

Summing up, the knowledge frame is direct outcome of net concerns, operating in extended enterprise unifying textures or into closed virtual settings of an integrated partnership. These backdrop technologies offer worthwhile solutions, when front-end decision supports are available [14,15,16].

3. Product-service Lifecycle Design

The sustainability builds on the availability of special purpose aids: PLM, product lifecycle management, SE, service engineering, RL, reverse logistics and related aids, to assemble data and to modify burning up and toxic waste end effects, by suited mitigation/removal of the main falloffs. The unifying super-model, for the coherent arrangement of the conditioning knowledge, distinguishes because of a set of specialised properties, Fig. 4, to reach whole inclusive product-process-environment-enterprise, 2P2E, balances, where the lifecycle externalities are dynamically accounted by in-progress adapting the enterprise functions and facilities, each time new environment requirements appear:

- varying-geometry boundaries, to expand over every view specifying to products-services;
- embedded simulation-emulation tools, to allow virtual behavioural experimentations;
- cooperative infrastructure, to support problem-solving issues, open to multiple-domain experts;
- automatic propagation of changes, with consistent updating of the super-model data-frame;
- straightforward evaluation of alternatives, trends, risks, etc., based on reliable relational schemes;
- rapid producibility, affordability, etc. analyses, performed via intelligent decision support;
- fast and accurate exploration of lifecycle occurrences, to broaden concept-to-production figures;
- efficient archival of globally accessible knowledge-bases, readily available in the current activity;
- ubiquitous service through the extended enterprise, enabling effective, inter-operable tools;
- any similar opportunities of advanced PLM surroundings, that the present IT tools can provide.

Fig. 4. Properties of the product-service lifecycle super-models.

The need to look at the enterprise level depends on the fact that earlier vertical flow-shops are, chiefly, replaced by horizontal job-shops, inserting auxiliary facilities and technologies, rooted in out-sourcing and productive break-up. The main manufacturing skills (strategic positioning, market assessment, resource planning, risk management, quality deployment, work-flow scheduling, factory management, operation programming, productive trimming, performance evaluation, productivity monitoring, finance/cost ruling, etc.) become interlaced concern, with commitment and responsibility distributed among several entities, and an optimal arrangement can only be achieved dynamically, after cooperative efforts and reconfiguring. The all, however, is, only, intermediate step, towards new arrangements, when suppliers responsibility will encompass product-service delivery, over the lifecycle span, recovery/remediation included. The way out looks at incorporating ambient intelligence, AMI, tools, Fig. 5, at the design stage.
In earlier economic systems, the wealth expansion depends on process productivity, aiming at affluent society, based on transforming raw materials into cheap items, ceaselessly replaced by new ones, better suited to users’ whims. Eco-protection, today, requires to limit pollution and depletion. New economic systems need to be devised, highly affected by supply chain externalities, out of the manufacturing phases. These new set-ups are prospected outcome of sustainability [17,18,19], as soon as governmental rules, to refrain from polluting and lower consumption, will require visibility on the supply chain [20,21]. The enterprise competitiveness turns, from the capability of offering new products (fit-for-purpose to individual needs), to the ability of providing services, granting the expected functions to personal satisfaction joint to better tangibles effectiveness (fit-for-purpose to general benefits). Such emerging business paradigms will profit of cooperative networked organisations, according to pertinent eco-protection approaches.

4. The ‘Sustainable Corporation’ Project

The ecology wants lifecycle responsibility of supplied products-services, rooted in net concerns, granted by product lifecycle manager, PLM, with service engineering, SE, and reverse logistics, RL, completions. Legal specification and official monitoring/certification of the eco-data are necessary prerequisite:
showing the *product-service* lifecycle characteristics
- granting *maintenance/recovery* balanced conditions
- accomplishing end-of-life *remediation/reclamation*
- using third-party body’s *accreditation/certification*

The PLM/SE/RL integration over the *product-process-environment-enterprise*, **2P2E**, span allows mingling the know-hows into the networked organisation of «sustainable corporation», Fig. 6, properly implemented under «settlement councils» ruling of the «big society» organisation [22,23].

![Diagram of networked organisation of sustainable corporation]

**Fig. 6.** The networked organisation of the sustainable corporation.

The technical accomplishments, basically, resort to standard computational frames, including:

- competing product-service choice, by *streamlined lifecycle assessment, SLA*, tools
- product-service delivery trimmed by *computer aided lifecycle inventory, CALI*, aids
- lifelong monitoring, diagnosis and evaluation, done exploiting *PLM-SE-RL* databases
- setting of *accredited/notified certification, A/NC*, bodies, for supply chain lawfulness
The certification has to be carried by free technical agents, which act in competition, under settlement councils ruling and replace the governmental authority control. This bottom-up organisation requires, at the background, notably modified infrastructures, aiming at the eco-project management, i.e., chiefly [24,25]:

- the sustainable corporation scenario, with notified certification bodies
- the big society empowerment, with acknowledged settlement councils

From merely technical standpoints, the eco-project requires replacing the conventional authority of the nation-states, by the spread-out governance of global village inhabitants. The analysis on the topics entails socio-political questions, not object of the present survey (even if included by the listed references); at the technological front-end, the recycling/recovery workforce happens to be prevailing, compared to the manufacture one, and the third party organisational business has to be fostered, Fig. 7, to supplant the old political spheres, by activities directly related with the eco-project management.

5. Conclusion

The survey moves along the sustainability themes, factually tackled through the extended enterprise technicalities. When the analysis remains at these levels, the industrial revolution happens needing a total rethinking, with knowledge build-ups in the domains of the mankind progress. The change course, surely, involves all the administrative, economic, political and social fields of the structured life in common, and at the backdrop the related themes deserve critical momentum. Nonetheless, the changeover profits by the focus on some instrumental details, such as the ones linked to the entrepreneurial courses and conditional knowledge alteration. A few hints are before summarised, limiting to bird eye remarks [26,27].

Compared to the traditional firm theory (the make-or-buy paradigm), the revolutionary change leads to re-thinking the market of functions, to cover, also, the enterprises creation, with traits such as:

- to trade facilities, with negotiation of timely adapted management aims
- to establish selection/acquisition/merging frameworks on ecology targets
In this market, the clients are extended enterprise rulers, devising business projects, and demanding the assembly of qualified partners. The traded items represent facilities/functions supply, having varying goals and technical heterogeneity, but supplying efficient interoperability in the given business. The all entails the advanced features of networked organisations. This does not necessarily correspond to a single corporation and could better be identified by a cluster of manufacture/service partners, possibly, time-varying, so that the business ruler is identified by the business and is the legal entity, having continuously up-dated below architectures of facilities/functions providers. So, it might happen that the purchaser of the product-service interacts at the point-of-sale with a business ruler representing an extended enterprise instance (say, a given set of facility/function providers), while at the ensuing points-of-service, the same business ruler agrees with new extended enterprise instances (say, modified sets of facility/function providers).

The fact, by itself, is not alarming: it might lead to separate (brand), from production/service facilities. The difference comes out from the lifecycle obligation, engaging the business ruler by respect to all the citizens, notably, for the eco-accomplishments. In the facilities/functions marketplace, the broker is an alliance or foundation, having the skill and competency in the integrated 2P2E design, for everything which concerns the business decision-making (choice, negotiation and integration) operation. The broker role is fundamental, enhancing the organisation effectiveness, strengthening trust between partners and assuring the supply chain stability (also in legal terms). It shall be recovery ruler, overseen by certification bodies, thus, he will negotiates the configuration/reconfiguration of the business organisation, including chosen facilities/functions providers, so that, at each considered time, the productive set-up achieves high reverse logistics effectiveness.

The ecology is little related to the interpersonal squabbles, up now, concerning the inhabitants of the different regions of the earth. We live in the same barge, with no chance to find alternatives: the splitting into nation states is meaningless, as our future has to be shared. The split sovereignty does not assure independence. The sustainability technicalities help understanding that technology-driven solutions are to be developed, when way-outs are sought.

References


