Startup Definition Proposal Using Product Lifecycle Management

Bernardo Reisdorfer-Leite, Michele Marcos de Oliveira, Marcelo Rudek, Anderson Luis Szejka, and Osiris Canciglieri Junior(✉)

Polytechnic School, Industrial and Systems Engineering Graduate Program (PPGEPS), Pontifical Catholic University of Paraná (PUCPR), Rua Imaculada Conceição, 1155, Curitiba, Paraná 80215-901, Brazil
{bernardo.leite, marcelo.rudek, anderson.szejka, osiris.canciglieri}@pucpr.br, michele.m@grupomarista.org.br

Abstract. Innovative products and services remain the primary drivers in innovation ecosystems. New ventures emerge in these ecosystems, and the number grows by the day. The leading ecosystems actors appoint the new firms as startups, and usually academics, and young entrepreneurs design and establish these recent ventures. Many studies state that startups impact positively in the economy, contribute to its development, explore new market possibilities by investigating concrete exponential problems. Nevertheless, there is a missing concept of what a startup is, and even among practitioners, there are a plethora of definitions. As a result, it is an emerging standard without an explicit and universal meaning. This matter is also supported by the lack of definition in scientific literature, that does not define and delimit clearly the boundaries and the exact moments that may nominate an enterprise as a startup. Therefore, an explicit definition could support innovation ecosystems actors, like Policy Makers and University and Company Managers to improve the effectiveness of the establishment of startups as the main ecosystems' output. Hence, this study aims to propose a preliminary and generic definition of startups, using the PLM concept perspective as a starting point, since PLM seeks to improve innovation through managing company's products across their lifecycles, from the first idea until its discard. To initiate the discussion, we compare the startup and product lifecycles, specially the Beginning of Life (BOL) and Middle of Life (MOL) phases.

Keywords: Startup · Startup lifecycle · Product lifecycle management · Innovation ecosystems

1 Motivation

The current world economy is witnessing an increase in the amount of innovation in the market. New enterprises are being created around the world exponentially, and the number grows by the day. It is given to them a specific status: startups. Currently, startups represent an influential model in the innovation economy. Not only offering innovative products, but equally contributing to job creation and productivity growth

Published by Springer Nature Switzerland AG 2020
F. Nyffenegger et al. (Eds.): PLM 2020, IFIP AICT 594, pp. 426–435, 2020.
https://doi.org/10.1007/978-3-030-62807-9_34

[1]. At the same pace that the number of startups grow in quantity and variety, they are additionally becoming a complex issue. There are many actors involved in their creation and development. From universities to incubators and accelerators, from mature companies to governments, among others.

The fundamental activity of a startup is to transform ideas into products, measure how customers respond, and then learn whether to pivot or persevere [2]. Through trial and error, hiring and firing, successful startups all invent a parallel process to product development [3]. The enterprise has a learning process running at the same time as the product is being developed. While the learning process is engaged in customer-centric activities mainly happening outside the enterprise, product development is focused on the product-centric activities that are taking place internally [4]. Although many startups fail at the first stages (nine out of 10 startups [5]), an entrepreneurial society facilitates this entrepreneurial driven economic growth through an institutional context which is conducive to entrepreneurial activity [6].

Limited resources and pressure to achieve growth, startups focus on product development rather than complex management structures. Since there are no internal barriers, the response speed to changes are higher than in large and com-plex enterprises. The value creation process starts with an idea. People co-create and initiate its development. After the development stage, the enterprise starts manufacturing, distributing and promoting the product or outsourcing the manufacture and distribution and only selling the product. In due course, the enterprise achieves a rate of growth. When the product or service achieve its maturity, the enterprise will presumably represent an established company.

According to [7] startups are companies set up to test business models developed around new ideas, typically, proposed by a number of co-founders or team members. [2] defines startups as a human institution designed to create an innovative product or service under conditions of substantial uncertainty. Some authors define the features of startups. [8] describes startups as a dynamism of form and merit, which results from functioning in a very unstable, unpredictable environment. However, each author has its own understanding of the concept [7] and there is no unique definition in literature on what constitutes a startup [9]. The previously mentioned definitions are generic, and this situation represents the lack in scientific literature regarding the definition of startups.

Since enterprises are not profitable and do not survive in its initial stages; the expected growth is supported by its successful product; in due course, they achieve a maturity level which they do not maintain an increasing growth in revenue. The previous assertion leads to the research question, which is: “during the lifecycle of an innovative enterprise (often called as startup), when could they be named as startup?”.

From the research question, we have determined the aim of this paper suggesting the moment that an enterprise might be denominated as Startup; according to the stage in its lifecycle and the stage of its product based on Product Lifecycle Management (PLM) concepts.

2 Background

2.1 Startup Lifecycle

We have not found in scientific literature studies that directly assess the startup lifecycle. Authors have been using various lifecycles models and frameworks to support diverse applications. In our starting literature screening, we have observed some models that can support our goal.

We took into account that the sequence of activities and stages might vary among various startups [10]. Nevertheless, the findings contain similarities among the lifecycle stages.

Some initial frameworks were proposed regarding Small and Medium Enterprises (SMEs) in the 80 s [11, 12], and they seem applicable to the startup context. Table 1 compares the two initial models and more recent models found in recent grey and scientific literature. Some notable studies are equally identified on non-scientific literature: [13] and [2]. In the same way [7] summarize that the lifecycle begins with an idea and ends with an exit strategy (merger, acquisition, IPO, etc.).

Table 1. Startup lifecycle in scientific and non-scientific literature.

Author	Application	Lifecycle stages
Churchill and Lewis [11]	SMEs	Existence, survival, success, take-off, resource maturity
Scott and Bruce [12]	SMEs	Inception, survival, growth, expansion, maturity
Salamzadeh and Kesim [10]	Lifecycle and challenges	Bootstrapping, seed, creation
Picken [14]	Enterprise culture	Startup, transition, scaling, and exit
Mańkowska [15]	Internet of Things	Seed, start-up, early growth, expansion, mezzanine, exit
Paschen [16]	Crowdfunding	Pre-startup, startup, growth
Overall and Wise [17]	Customer development	Pre-seed, early stage, expansion, later stage
Startup Genome [13]	Startup ecosystems	Discovery, validation, efficiency, scale, sustain, maintain, decline

As stated in Sect. 1 the concept of startup is diverse in academia. However, among practitioners, the most acceptable startup lifecycle is the model related to the financing cycle (Fig. 1). As the reason for the existence of an enterprise is to generate profit, we corroborate with the affirmation as being the basic metric to commence this study. Therefore, we compare it with Product Lifecycle (PLC), since an enterprise make profit by selling its products and services. The startup lifecycle specificities are presented in Sect. 3.

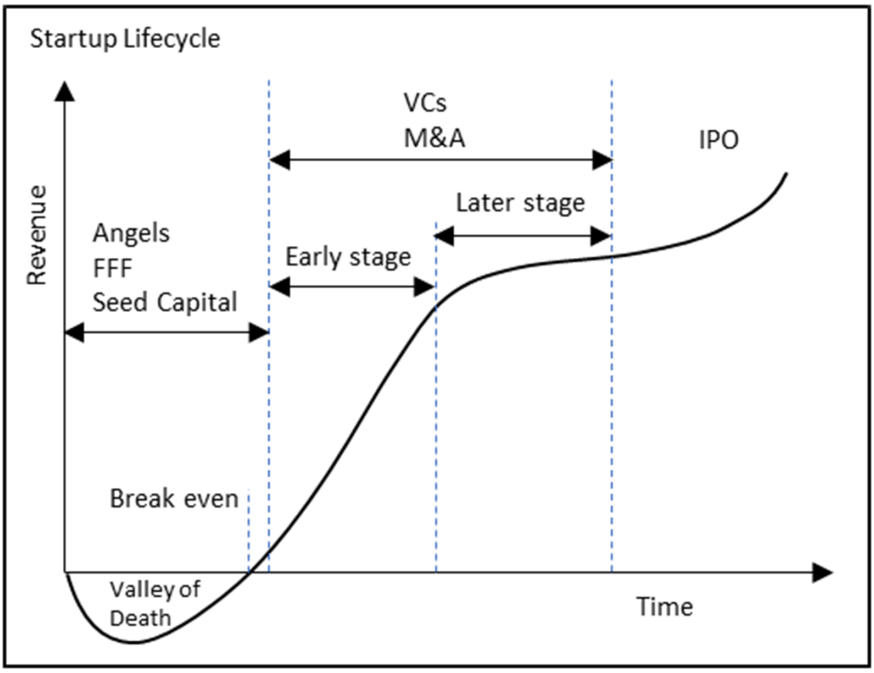

Fig. 1. Startup lifecycle. Adapted from [18].

2.2 Product Lifecycle Management

Product Lifecycle Management (PLM) is the business activity of managing, in the most effective way, a company's products, all the way across their lifecycles; from the very first idea for a product all the way through until it is retired and disposed of [19]. [20] define PLM as a strategic business solution for integrating people, information and processes across the extended enterprise through a common body of knowledge. The body of knowledge within an enterprise is comparable to a living organism which its health directly affects enterprise's ability to operate and compete effectively.

In modern product development, as the complexity and variety of products increase to satisfy increasingly sophisticated customers, so does the need for knowledge and expertise for developing products [20]. In this context, PLM aims at reintegrating the manufacturing organization by closing all the knowledge loops and positioning the product at the focal point of the whole organization. It is about reinventing and revitalizing the cobbler model for the information age [20].

Products generate a large amount of information during their lifecycles [21] and the PLM concept promises to provide support for the product's entire lifecycle; from the first conceptualization to the disposal of its latter instance. The volume, diversity, and complexity of information describing the product will increase correspondingly [22].

One of the advantages of adopting PLM is the knowledge base generated by the product in its lifecycle. A rich knowledge base, in turn, can potentially improve the

efficacy of knowledge-intensive processes, thus resulting in better overall cash flow and competitive standing [20].

In general, the product lifecycle consists of three main phases: beginning of life (BOL), including design and production; middle of life (MOL), including logistics (distribution), use, service, and maintenance; and end of life (EOL), including reverse logistics (collecting), remanufacturing (disassembly, refurbishment, reassembly, etc.), reuse, recycle, and disposal [23] (Fig. 2).

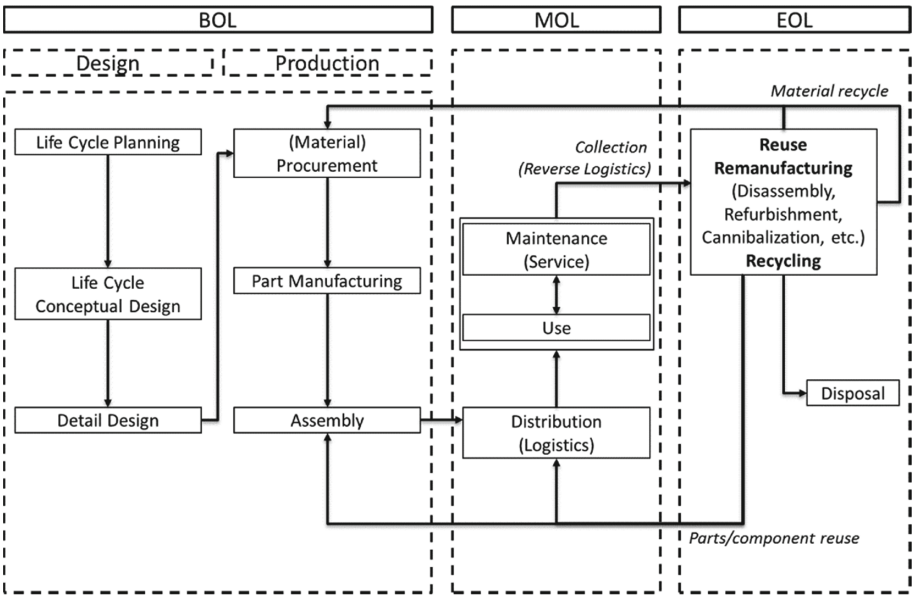

Fig. 2. Product lifecycle. Extracted from [22]

3 Application and Discussion

Our proposal encompasses the following concepts to explain when a new innovative firm should be called as startup. The first concept the knowledge base created across the three main stages of product lifecycle (BOL, MOL and EOL). The second concept is the startup lifecycle. Our basis represents the scientific literature regarding the startup lifecycle to propose the stage which an enterprise is a Startup. Figure 3 explains the concept model as well as the discussion below.

As described in Sect. 2.1, we suggest the enterprise revenue as the primary driver to explain the startup phases, since we suggest that is direct linked with its products and services.

When the enterprise initiates its operations, we presume the group of people do not develop any concrete innovative product. They start with an idea and must materialize into a product completely developed. Financial results are negatives due to costs of management and the initial stages of product development (BOL). The initial place of

the enterprise in its lifecycle is designated the Valley of Death [24]. To survive the valley of death, the enterprises rely on financing from Friends, Family and Fools (FFF) [25], Angel Investors [26] and Seed-capital [27]. Many enterprises do not survive the Valley of Death [5]. We consider the point of surviving the Valley as the Mark nº 1 (M1).

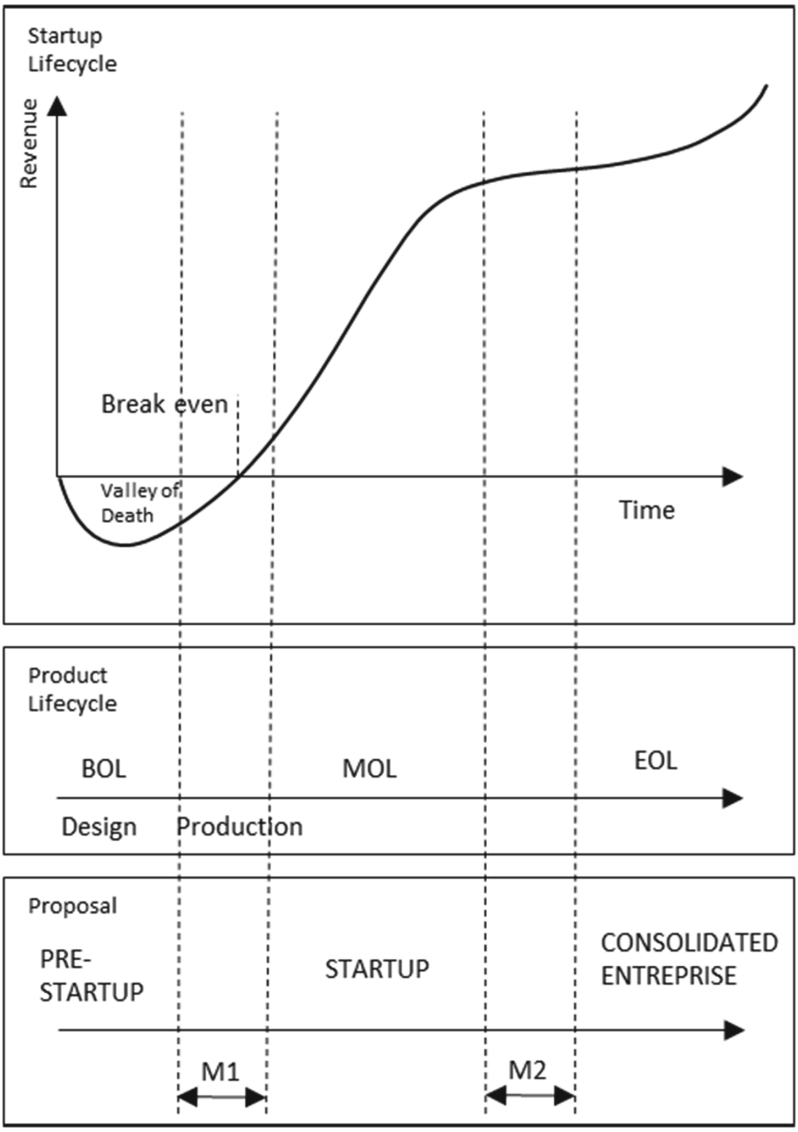

Fig. 3. Conceptual model proposition.

[3] suggests that through trial and error, hiring and firing, successful enterprises (startups) all invent a parallel process to product development. In particular, the winners invent and live by a process of customer learning and discovery. At this point the enterprise has likely generated a substantial knowledge base about the product BOL stage. Simultaneously, it has also developed management knowledge to start dealing with internal and external uncertainties, and probably the most significant achievement, it has reached the break-even point.

We suggest that enterprises situated in the stage before M1 might be called as PRE-Startups. Their key features are that they have not achieved enough revenue to swell, however they achieved a considerable knowledge base to learn with management and product commercialization. As the process is not linear nor precise, we determined a confidence level which the M1 might be located.

The enterprises that have survived to the Valley of Death and overpassed the M1, apparently will experience a rapid growth. The revenue growth is sustained in product BOL and MOL stages. The enterprise, in addition, receives resources from Venture Capital (VC) [28], Mergers and Acquisitions (M&A) [29], strategic alliances, etc. After rounds of investments, the firm achieve a plateau of revenue and rely on product updates and improved innovations.

When the product achieves its maturity on sales, its decline could be extended, or the enterprise launches an innovative product. Nevertheless, at this point the firm probably had already collected a substantial knowledge base regarding product MOL stage. With a consolidated product, uncertainties levels are low, allows the enterprise to know better about consumers, suppliers and competitors. When the enterprise achieves this stage, probably its revenue is with a low growth rate. We consider this point as Mark nº 2 (M2).

We suggest that from M1 to M2 the stage might be called as Startup. After M2, the enterprise achieves a maturity level, and it exits via Initial Public Offering (IPO), M&A. As mentioned earlier in M1, we suggest a confidence level which the M2 might be. Table 2 summarizes the proposition.

Table 2. Classification criteria of PLM and startup lifecycle.

Proposal	PLM stages	Investment sources	Revenue growth behaviour
Pre-startup	BOL	FFF, Angel Investors, Seed-capital	Negative until the break-even
Startup	BOL/MOL	VC, M&A, strategic alliances	Rapid growth
Consolidated enterprise	MOL	IPO, M&A	Low growth

4 Conclusion and Outlook

The present study is a preliminary proposition that aims to increase the entrepreneurship culture. The purpose of this paper was to propose an alternative conceptual definition of Startup stage in innovative enterprises (startups) using primarily BOL and MOL of PLM concepts. This paper does not intend decreasing entrepreneurial initiatives. On the contrary, we propose the study to incentive more entrepreneurs to launch their enterprises and obtain successful outcomes.

As new enterprises develop their products and gain management skills simultaneously, and both influence each other in a learning experience; it seems reasonable that an enterprise might be defined as Startup if it overpasses the M1; notably because it had survived to the Valley of Death, and is located before M2. Put differently, their product should be in MOL stage, and the enterprise must be experiencing growth in their revenue. The categorization of these enterprises in Pre-Startups and Startup are necessary because many Pre-Startups fail in the Valley of Death.

This proposal attends an initial discussion regarding this theme. Further studies are necessary especially the use of PLM as an alternative to allow entrepreneurs to develop better products that allow then to overpass the Valley of Death. A typical feature of innovative enterprises and SMEs represent the lack of resources; as in [30], Open Innovation strategies with PLM would be a compelling initiative to provide scientific evidence and body of knowledge to increase the successful rate of entrepreneurs. The introduction of the solution developed in the knowledge intensive collaborative environment proves to be very effective and efficient, leading to good results in terms of savings [31]. In parallel, to deal with management knowledge, enterprises have available several sources of knowledge like mentoring, accelerator programs, etc.

In addition, more criteria are necessary to enrich the discussion of defining when an enterprise is a Startup. It is explicit that not all SME is a Startup. It might be understandable in further studies to define when large companies once tagged as Startup should not have this label anymore.

Acknowledgements. The researchers would like to thank the Pontifical Catholic University of Paraná (PUCPR) - Polytechnic School – Industrial and Systems Engineering Graduate Program (PPGEPS) and National Council for Scientific and Technological Development (CNPq) for the funding and structure of this research.

References

1. Decker, R., Haltiwanger, J., Jarmin, R., Miranda, J.: The role of entrepreneurship in us job creation and economic dynamism. J. Econ. Perspect. **28**(3), 3–24 (2014)
2. Ries, E.: The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown (2011)
3. Blank, S.G.: The Four Steps to the Epiphany (2007)
4. Wang, X., Edison, H., Bajwa, S.S., Giardino, C., Abrahamsson, P.: Key challenges in software startups across life cycle stages. In: Sharp, H., Hall, T. (eds.) XP 2016. LNBIP, vol. 251, pp. 169–182. Springer, Cham (2016). https://doi.org/10.1007/978-3-319-33515-5_14

5. Krishna, A., Agrawal, A., Choudhary, A.: Predicting the outcome of startups: less failure, more success. In: IEEE International Conference on Data Mining Workshops ICDMW, pp. 798–805 (2016)
6. Audretsch, D.B.: From the entrepreneurial university to the university for the entrepreneurial society. J. Technol. Transf. **39**(3), 313–321 (2012). https://doi.org/10.1007/s10961-012-9288-1
7. Salamzadeh, A., Kawamorita Kesim, H.: The enterprising communities and startup ecosystem in Iran. J. Enterprising Commun. People Places Glob. Econ. **11**(4), 456–479 (2017)
8. Kopera, S., Wszendybył-Skulska, E., Cebulak, J., Grabowski, S.: Interdisciplinarity in tech startups development-case study of 'Unistartapp' project. Found. Manage. **10**(1), 23–32 (2018)
9. Paternoster, N., Giardino, C., Unterkalmsteiner, M., Gorschek, T., Abrahamsson, P.: Software development in startup companies: a systematic mapping study. Inf. Softw. Technol. **56**(10), 1200–1218 (2014)
10. Salamzadeh, A., Kawamorita Kesim, H.: Startup companies: life cycle and challenges. SSRN Electron. J. (2015)
11. Churchill, N., Lewis, V.: The five stages of small business growth. Harv. Bus. Rev. **61**(3), 30–50 (1983)
12. Scott, M., Bruce, R.: Five stages of growth in small business. Long Range Plann. **20**(3), 45–52 (1987)
13. Global Startup Ecosystem Report. Startup Genome LLC, San Francisco (2019)
14. Picken, J.C.: From startup to scalable enterprise: laying the foundation. Bus. Horiz. **60**(5), 587–595 (2017)
15. Mańkowska, N.: Startups in Poland on the internet of things market: development and life cycle. In: Proceedings of European Conference on Innovation and Entrepreneurship ECIE. 2 (Bartczak), pp. 621–628 (2019)
16. Paschen, J.: Choose wisely: crowdfunding through the stages of the startup life cycle. Bus. Horiz. **60**(2), 179–188 (2017)
17. Overall, J., Wise, S.: An S-curve model of the start-up life cycle through the lens of customer development. J. Priv. Equity. **18**(2), 23–34 (2015)
18. Understanding the enterprise startup lifecycle. https://www.zdnet.com/article/understanding-the-enterprise-startup-lifecycle/
19. Stark, J.: Product Lifecycle Management. Springer, Cham (2015). https://doi.org/10.1007/978-3-319-17440-2
20. Ameri, F., Dutta, D.: Product lifecycle management: closing the knowledge loops. Comput. Aided Des. Appl. **2**(5), 577–590 (2005)
21. Bruno, G., Antonelli, D., Villa, A.: A reference ontology to support product lifecycle management. Procedia CIRP **33**, 41–46 (2015)
22. Sudarsan, R., Fenves, S.J., Sriram, R.D., Wang, F.: A product information modeling framework for product lifecycle management. Comput. Des. **37**(13), 1399–1411 (2005)
23. Jun, H.B., Kiritsis, D., Xirouchakis, P.: Research issues on closed-loop PLM. Comput. Ind. **58**(8–9), 855–868 (2007)
24. Reagle, C., et al.: From idea to prototype: introducing students to entrepreneurship. In: ISEC 2017 - Proceedings of the 7th IEEE Integrated STEM Education Conference, pp. 71–75. IEEE (2017)
25. Kotha, R., George, G.: Friends, family, or fools: entrepreneur experience and its implications for equity distribution and resource mobilization. J. Bus. Ventur. **27**(5), 525–543 (2012)

26. Mitteness, C., Sudek, R., Cardon, M.S.: Angel investor characteristics that determine whether perceived passion leads to higher evaluations of funding potential. J. Bus. Ventur. **27**(5), 592–606 (2012)
27. Alves, S., Pimenta-bueno, J.A.: Quantifying the capital requirements of start-ups in early growth phase: exploratory evidence from a seed capital fund in Brazil. J. Private Equity **21** (3), 26–37 (2018)
28. Florida, R., Mellander, C.: Rise of the startup city. Calif. Manage. Rev. **59**(1), 14–38 (2016)
29. Pisoni, A., Onetti, A.: When startups exit: comparing strategies in Europe and the USA. J. Bus. Strategy **39**(3), 26–33 (2018)
30. Reisdorfer-Leite, B., Marcos de Oliveira, M., Canciglieri Junior, O.: A discussion about science, technology, engineering and mathematics education in the university R&D and its impact on the innovation and environment ecosystem. In: 8th IWACP international Workshop Advances in Cleaner Production, Sanya, pp. 75–76 (2019)
31. Ferreira, F., Faria, J., Azevedo, A., Marques, A.L.: Product lifecycle management in knowledge intensive collaborative environments: an application to automotive industry. Int. J. Inf. Manage. **37**(1), 1474–1487 (2017)