Lean Product and Process Development and Set-Based Concurrent Engineering in the Dining Industry: the experience of an American-Asian fusion restaurant

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Abstract: The purpose of this paper is to investigate the implications of a culinary innovation process when adopting manufacturing industry concepts such as LPPD: Lean Product and Process Development. The action research structured in five steps (semi-structured interviews, process mapping, training, and implementation of a new process, process observation, and compilation/feedback of results) allowed the introduction of the LPPD in the culinary innovation process. Results showed that despite the innovation process of a restaurant being based on tacit knowledge, concepts from the manufacturing innovation process could be adopted. Findings can contribute to the multidisciplinary studies involving innovation, the hospitality industry, and the action research application on operations management.

Keywords: Dining innovation, Culinary innovation, Lean Product Development, Set-Based Concurrent Engineering, product development

Desarollo de processos y productos Lean y ingeniería simultánea en negocio gastronómico: el experiencia de un restaurante de fusión americano-asiático

Resumen: El propósito es investigar las implicaciones de un proceso de innovación gastronómica cuando se adoptan conceptos de la industria manufacturera como LPPD – Lean Product and Process Development. La investigación-acción estructurada en cinco pasos (entrevistas semiestructuradas, mapeo de procesos, capacitación e implementación de un nuevo proceso, observación del proceso y recopilación / retroalimentación de resultados) permitió la introducción de la LPPD en el proceso de innovación gastronómica. Los resultados mostraron que a pesar de que el proceso de innovación de un restaurante se basa en el conocimiento tácito, se pueden adoptar conceptos del proceso de innovación manufacturera. Así, esta investigación puede contribuir a los estudios multidisciplinarios relacionados con la innovación, la industria de la hospitalidade y la aplicación de investigación-acción sobre gestión de operaciones.

Palabras clave: Innovación gastronómica, innovacíon culinaria, Desarrollo de product lean, Ingeniería Concurrente, Desarrollo de productos

1. Introduction

Continuous improvement methodologies and practices in the hospitality industry are at the core of the development of new products and processes. The food industry particularly has several examples of innovative product development that are part of society's life, to name a few: pasteurised milk, infant formula, canned food, and gluten-free foods (Mishra 2016). However, scholars have been neglecting studies involving both products and process areas (Farrington et al. 2018). Product and process development are critical activities employed by most companies to remain competitive, regardless of the industry type or size. Through the new product development processes, companies seek commercial viability, competitiveness, profitability, and effectiveness, and therefore innovation plays a central role (Hébert and Link 2006).

Among different product and processes development approaches, those improved by the Toyota automaker gained prominence (Liker 2004; Monden 2011; Shingo and Dillon 1989). The Lean Product and Process Development (LPPD), based on Toyota's Product Development System and introduced in the early nineties, focused on a tripod, based on value, knowledge, and improvement (Womack et al. 1990). Also, Set-Based Concurrent Engineering: SBCE played an essential role in the development and design of new products in Toyota (Ward et al. 1995). In this latter approach, creators explicitly communicate and share their set of alternatives, instead of presenting a single *point to point* design, in which the designing process moves step by step. The success of these models helped Toyota to reach the leading position in the car manufacturing industry in the last decade.

Despite the significant contributions of these models to improving efficiency in the manufacturing sector and increasing academic production, their implementation in other industries is scarce. Recent studies discuss the application of lean principles in health care, (Drotz and Poksinska 2014; Poksinska et al. 2017; Tay 2016; Vinodh 2018), financial services (Delgado et al. 2010; Vashishth et al. 2017) and public sector (Antony et al. 2016; Antony et al. 2017), but none in the dining industry.

According to Harrington (2004), in the dining business innovation has not been clearly articulated regarding products and processes. Restaurant business owners recognise the importance of innovation. However, they find difficulties in establishing a systematic practice to create and design new menus (Ottenbacher and Harrington 2007). The food and hospitality businesses require a continuous innovation process, in order to attract consumers and thereby create a sustainable business model (Chattopadhyay and Shah 2014; Cho et al. 2018).

Levitt (1972; 1976) criticised the transference of manufacturing logic for servicing operations. Notwithstanding, a sequence of works, especially in the 2000s brought the universal contribution of lean thinking for organisations: Middleton (2001) in software development, Comm and Mathaisel (2003) in the context of academia, Swank (2003), Leite and Vieira (2015) and Smith et al. (2017) for servicing business. Those authors suggested that principles of lean thinking are universal, and can bring benefits to the organisation. Therefore, service companies can improve efficiency implementing manufacturing principles in their operations, mainly due to the *mass customisation* effect: – the use of flexible processes and structures to produce varied and individually customised products at the low cost of a standard product. (Bowen and Yiungdahl 1998).

Thus, is it possible for restaurant owners and chefs to implement innovative process and product development, based on consolidated practices such as LPPD, and SBCE? Recommendations of LPPD practice could be added to the chef's innovative process, so that product development would create more value for the customer. (For example, how SBCE could improve the screening process and consequently the trial and error process?) Likewise, is it possible to identify similarities in the product development process of renowned chefs, like Michelin-starred chefs, and those concepts?

The innovative process in an American-Asian fusion restaurant in the City of Sao Paulo, Brazil, will be studied based on those questions. Through an action-research approach, it aims to contribute with the theoretical basis of the innovation process in the dining industry (which can also be found as a *food service industry* in the literature), adding knowledge to the past works of Harrington (2004) and Ottenbacher and Harrington (2007).

Simultaneously, this paper contributes to strengthening the literature of action research application in operations management, as the examples of Westbrook (1993), which developed a classification scheme based on complexity for priority management, and Karlsson and Åhlström (1996) which studied the implementation of lean product development in a company.

The paper structure comprises a Literature Review in Section 2, followed by the Research Method in Section 3. Results and Discussions are described respectively in Sections 4 and 5.

2. Literature review

The following section reviews the classical literature regarding LPPD and SBCE, as well as the application of the innovation process in the dining industry. Additionally, due to the scarce literature related to innovation in the dining industry, we took into account some old as well as recent literature, but focus on two significant contributions to our understanding of the industry, the research of Ottenbacher and Harrington (2007).

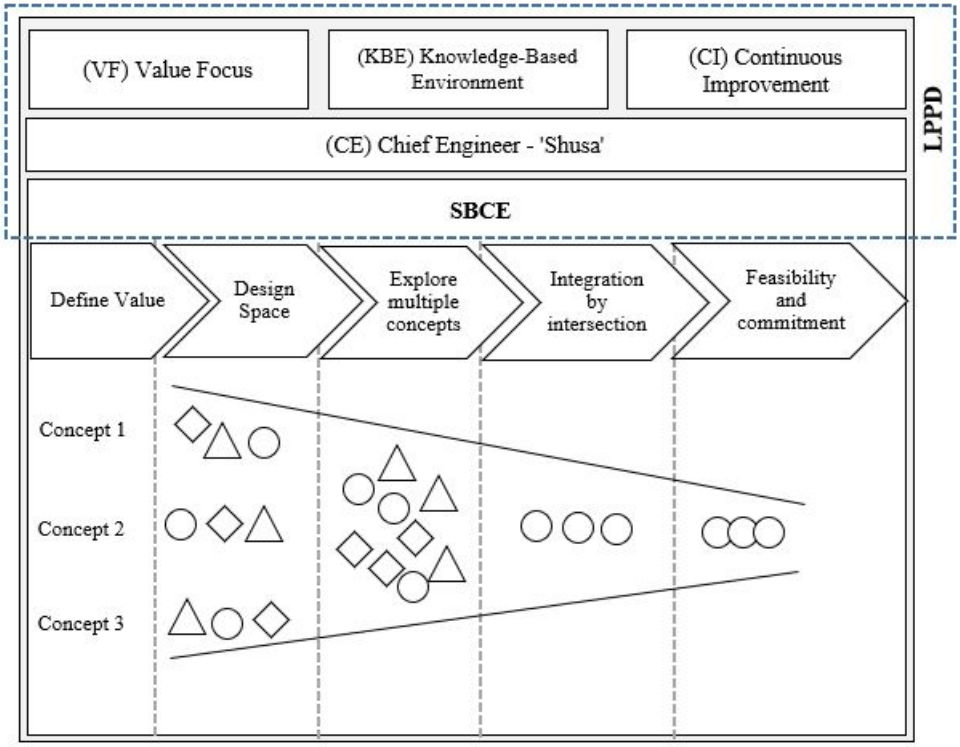
2.1 LPPD: Lean Product and Process Development and SBCE: Set-Based Concurrent Engineering

The term Lean was coined by Krafcik (1988) and most popularised through the Womack et al. (1990) best-selling management book *The Machine that Changed the World*. It is *Lean* in terms of outputs as the process that *compared to mass production it uses less of everything – half the human effort in the factory, half the manufacturing space, half the investment in tools, half the engineering hours to develop a new product in half the time* (Womack et al. 1990 p. 13). Researchers involved in the MIT International Motor Vehicle Programme discovered that Toyota Motors trained and empowered its workers to implement the Kanban and Just-In-Time system, solving any problem related to the flow of production. They found that the lean concept demands more communication in all directions to improve quality, reduce costs, and production time.

Based on the Toyota lean production system, the LPPD has its roots in the maximisation of value while minimising waste. According to Khan et al. (2011), the LPPD has been addressing the needs of European manufacturing companies for going beyond lean manu-

facturing and incorporating lean thinking in the product design development process (Khan et al. 2011). Companies had been applying this practice to improving manufacturing processes (Baines et al. 2006; Khalil and Stockton 2010), but just a few applied lean thinking to product and process innovation (Al-Ashaab and Sobek 2013). This model is based on five concepts: value focus (VF), knowledge-based environment (KBE), continuous improvement: Kaizen (CI), chief engineering (CE) and Set-Based Concurrent Engineering (SBCE), being the latter the guide of the LPPD model as shown on Figure 1.

Fig 1: SBCE and LPPD concepts and processes



SBCE is defined as a process where sets of solutions for different sub-assemblies and components are developed in parallel (Ward 2007). The parallel development starts narrowing according to the progress of testing and prototyping, generating a knowledge base, which will support coherent opinions in the decision process (Al-Ashaab et al. 2016; Sobek et al. 1999). Based on the works of Morgan and Liker (2004), Sobek et al. (1999), Ward et al. (1995) and Ward (2007), we can propose that SBCE has five categories and a set of principles which are i) Strategic value research and alignment; ii) Map the design space; iii) Create and explore multiple concepts in parallel; iv) Integrate by intersection and v) Establish feasibility before commitment.

Strategic value research regards the capture and identification of customer value and innovation, reflecting those in the company strategy. *Map the design space* defines frontiers

between feasible and infeasible aspects of the development, which can be related to the definition of the scope. *Create and explore multiple concepts in parallel* regards the capacity of the development team to utilise acquired knowledge to evaluate the different sets of design solutions and constraints. *Integrate by intersection* is the exploration and testing of different sets, eliminating weaker solutions. Finally, *Establish feasibility before commitment* will wrap-up the findings, decide the final set, and release the team commitment. Along with these five principles, there is the concept of *Trade-Off Curves* (ToC), which is a crucial tool to support decision-making in the product development process. For example, ToC can support identifying the feasible area of development, generate a set of designs, compare alternative design solutions, trade-off, and narrow down the set of solutions (Morgan and Liker 2006; Oosterwal 2010; Sobek et al. 1999; Ward and Sobek II 2014).

2.2 Innovation process in the dining industry by Harrington (2004) and Ottenbach & Harrington (2007)

The traditional view of the innovation process was proposed by Utterback (1971) and consisted of a set of steps and practices which are i) idea generation, ii) problem solving, iii) implementation and iv) diffusion. Other authors like Wheelwright and Clark (1992) contributed to the development of the funnel concept: generation and screening a broad range of inputs with further refining selection of subsets to reach the product concept. Cooper (1990; 1993; 2008) coined the concept of product development organised in sequential stages, or as he called stage-gates, which is a system or process that maps out *what needs to be done* as well as how to do it, in order *to win the game*. In the idea of Cooper, the innovation process has predefined phases: idea and discovery stage, scoping the case, business case, development, testing, and launching.

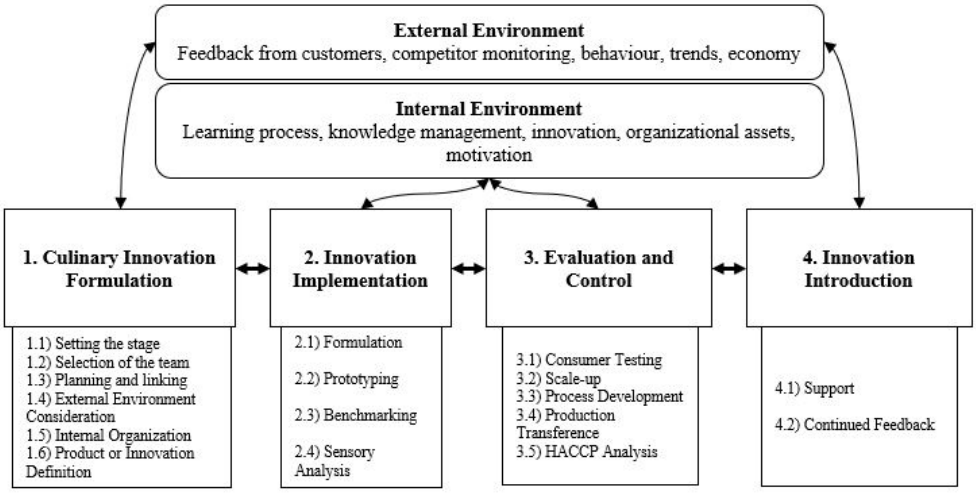
A stage-gate process, if well implemented, can boost-up the organisation's product development and innovation process (Trott 2005). However, the stage-gate process received some criticism, being considered time-consuming, bureaucratic, and restricting learning opportunities (Grönlund et al. 2010). Pich et al. (2002) and Rice et al. (2008) proposed that projects and product design have a high level of uncertainty, and consequently, traditional approaches may not be adequate. Besides, in the specific case of Project Management literature, Shenhar (2001) proposed that a standardised process or system like the prescriptive-type of a stage-gate system may find some challenges to the innovative processes.

Based on those pieces of evidence, it seems that there is no consensus in the literature on what model or idea should be implemented to innovate products and processes in the industrial sector. In the food product development, disagreements are more apparent. For Rudolph (1995), Pyne (2000), and Stewart-Know et al. (2003), the current models of innovation in the food product development are based on manufacturing concepts, which do not reflect the peculiarities of a food service operation. Food service is unique, since it requires efforts in the areas of service and product innovation process (Ottenbacher and Harrington 2009). Moreover, innovation in food service occurs in several areas, such as products, services, processes, management, and marketing (Lee et al. 2016) and, therefore, an organic model integrating strategic planning, marketing, food science, and operations is required.

There is evidence that innovation can help food service businesses to improve quality and reputation and, at the same time, improve profitability (Ottenbacher and Gnoth 2005).

Furthermore, speed, interaction, and iteration are needed to imitate a difficult competitor's imitation (Fuller 2011; Harrington 2004; Lee et al. 2018; Ottebacher and Harrington 2007). Harrington (2004) proposes an innovative model for the food industry, broken into four main phases: i) culinary innovation formulation; ii) innovation implementation; iii) evaluation and control; and, iv) innovation introduction. To visualise these four main phases, we adapted Figure 2 from the work of Harrington (2004).

Fig 2: Culinary product innovation process



These four main phases are composed of 17 elements in a process. According to Harrington (2004), culinary product innovation is the conceptualisation, development, launch, and ongoing management of new culinary innovation. Six elements summarised below compose this stage:

i) *Setting the stage*, which is the process to align firm objectives with external environment demands, plan organisation, and potentialise the communication tools and plans in order to have the best interaction with consumers and suppliers.
ii) *Selection of the team* looking for members from different functions.
iii) *Planning and linking* customer needs and innovation with technical and functional demands.
iv) *External environment considerations*, which considers competitors' actions, regulation, markets, seasonality, and trends.
v) *Internal organisation*, which analyses the capability of the available resources, knowledge and experiences, understanding strengths, and weaknesses; and,
vi) *Product or innovation definitions*, which gather and link prior elements to define the concept and the innovation-line proposed by the business.

The innovation and implementation phase is composed of four elements, which are: i) *Formulation*; ii) *Prototyping*; iii) *Benchmarking* and, iv) *Sensory analysis*. A key point in

this phase is the iterative process of the four elements because the characteristics of food service business require a dynamic approach and quick response. Accordingly, the formulation and prototyping of a new product may be tested during a seasonal menu. At the same time, similar competitor's menus can be benchmarked while customer experiences and feedbacks are collected either internally or externally.

The evaluation and control phase consists of an iterative process in which customer feedbacks feed the innovation process so that a product can be adjusted quickly. *Consumer testing* is a necessary procedure to create a direct feedback link with the innovation formulation process. The following three elements are related to the stability and robustness of the production. *Scale-up*, similar to a traditional manufacturing process, consists of the process of increasing the production volume, on a larger scale, ensuring that quality and productivity will be constant. *Process development and production transference* will ensure that developed products will have a minimum variation during the mass-production process. Therefore, aspects like the consistency of the production process, quality loss of the product under a sort of circumstances (e.g., box condition, weather variation and served plate), easiness for employees to reproduce the original recipe; and, availability of ingredients in all locations (in case of branch stores, for examples) are analysed carefully (Harrington 2004; Schonberger 1994).

The final step is the rollout of the process, which is similar to the development of any other standard product. In this phase, the product will be *introduced in the market* to compete against other products, and therefore, frontline employees must be adequately trained (Rudolph 1995). Food service businesses are represented by hosting and serving staff, bartenders, *maîtres*, and managers. The role of those employees is essential for the iterative innovation process because they will be the link between the customer and product developers.

The food service innovation process designed by Harrington (2004) was further improved by Ottenbacher and Harrington (2007), based on Michelin's innovation model, which has seven main steps: idea generation, screening, trial and error, concept development, final testing, training, and retail.

Idea generation is based on pillars like inspiration sources, product considerations, and complemented by the tacit creativity skills of the chef. Inputs of this process can be, for example, the literature, chef personal experiences, education, visiting, and being in contact with new technologies, concepts, and other restaurants.

Screening is related to making projections of the idea being concretised. It means projecting if the creation will fit the operation, chef style, customer demands, and acceptance. It is a distinct process, which also occurs in the later stages of the creational process, serving as a *check gate.* However, unlike the generic innovation process, the screening of chefs is an informal process (Ottenbacher and Harrington 2007).

Two main sub-processes comprise trial and error, which are a mental trial and error (*cooking in your head*) and a practical trial (*giving a shot*) giving inputs to *Concept Development*. This process will provide improvements to the creation by introducing ideas coming from market research (formal or informal, regarding pricing and customer needs), preparing formal recipes, thinking about differentiation factors (for example, an authentic cooking style, distinct harmonisation, or concept).

Final testing is performed through the preparation of the creation and testing it on one or more sources like trusted employees, partners, and regular customers. It may consider the entire aspect of the experience a part of the taste and appearance of the creation, considering the atmosphere of the experience and the service provided.

Training and Retail (or commercialisation) processes are essential to assuring the stability of the innovation process, since the former will assure the quality level of the production in a "mass production" situation. At the same time, the later will give essential inputs for iteratively to improve the product development process.

3. Research method

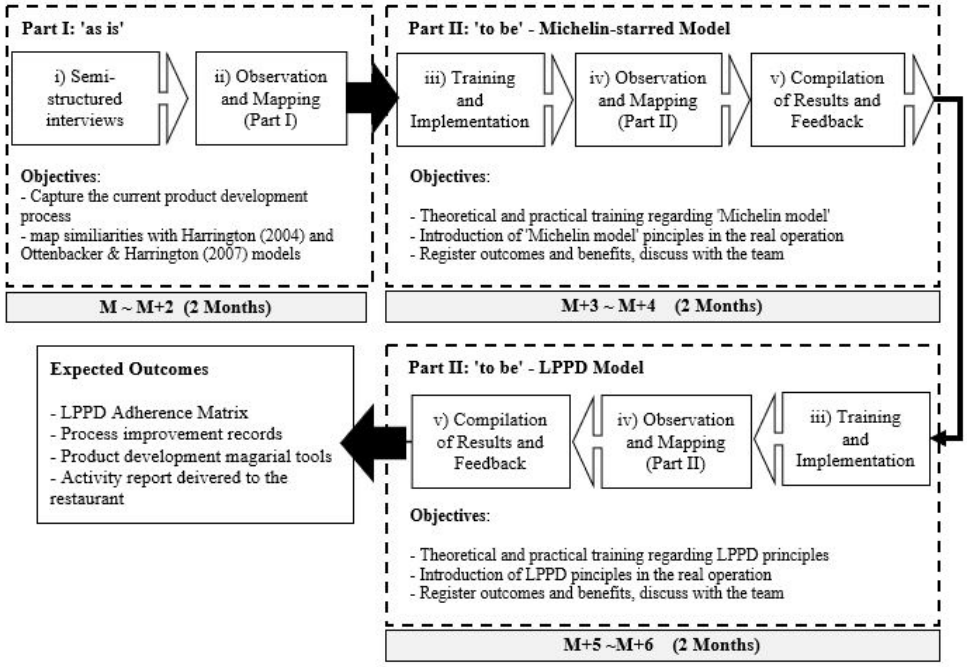
For this study, we employ the action research method, understanding that this is the best approach to integrating theory and practice in the work. In general, action research is appropriate to unfold actions over time in a given group, understanding how and why their action can improve the work system, and understanding the improvement process to learn from it (Coghlan and Brannick 2001). Action research goes beyond the notion that theory can inform practice, and a theory can and should be generated through practice (Brydon-Miller et al. 2003) and should influence social changes. Dining (food service) business innovation and production are mostly practical activity, where the *learning by doing* system is very present. Consequently, the action research comes as a new method to search the possibility for restaurant owners and chefs to implement innovative process and product development, based on consolidated practices such as LPPD, which also includes SBCE. Furthermore, if it is possible to identify similarities in the product development process of renowned chefs, like Michelin-starred chefs, Harrington's Culinary Product Development Model with those based on the LPPD approach commonly used in the manufacturing industry.

To look for answers for these questions, we developed action research divided into five phases: i) Semi-structured interviews and ii) Observation and mapping that comprises the Part I of the study. In this part, the focus of our investigation is to understand the as-is process of the restaurant's product development. Part II of the study comprise the iii) Training and implementation, iv) Observation and mapping: Part II; and v) Compilation of results and feedback. The focus is on understanding the to-be enhanced process and assessing the benefits and improvements in the creation and launching of a new product. A schematic view of the method and action research phases is shown in Figure 3. These phases are aligned with the action research cycle proposed by Coughlan & Coghlan (2002), which comprises a pre-step (to understand context and purpose- aligned with Part I, phase i); six main steps (to gather, feedback, and analyse data: aligned with Part I, phase ii , and to plan, implement and evaluate action: aligned with our Part II, phases iii, iv, v; and a meta-step to monitor: aligned with phase v. This cyclical approach, along with more rigorous inquiry and documentation processes, and the search for theoretical justifications rather than empirical justifications, distinguishes the action research from a consultancy activity (Gummesson 2000).

Moreover, an adherence matrix of the restaurant's product development process and LPPD components, which are value focus (VF), knowledge-based environment (KBE),

continuous improvement (CI), chief engineer (CE), and set-based concurrent engineering (SBCE) is proposed.

Fig 3: Action research phases and scheme



These five phases intend to cover ten significant characteristics of action research laid out by Gummesson (2000):

(1) *Action researchers take action*: researchers are not limited to observe the phenomenon, and therefore, actively participated in the menu creational process with the chef, trained and collected the feedback of new creational models, discussing the outcomes of the process implementation with the stakeholders;
(2) *Action research always involves two goals*: in the present research, the outcomes are twofold: solve a problem of knowledge management and product innovation process in an industry that relies on the tacit knowledge of the main actor (chef) while contributing to the theory of building in a cross-knowledge area;
(3) *Action research is interactive*: the interaction is observed through the co-operation of the researchers, chefs, investors, and other stakeholders, who are considered co-researchers. This process is evidenced during the two sessions of training and implementation, collection of results, feedback sessions, raising unfolding and unpredictable events during the study;
(4) *Action research is fundamentally about change*: action research applies to the understanding, planning, and implementing change (Nadler 1998; Coghlan and Brannick

2001). The research created the need for change, articulated the desired outcome from change, and actively planned and implemented that desire.

(5) *Action research aims at developing holistic understanding*: researchers navigated through the several subsystems of the organisational structure, working with the dynamic complexity of the culinary innovation process, business processes, and stakeholder relationship processes.

(6) *Action research can include all types of data gathering methods*: although interviews and surveys are commonly used, the critical aspect is the use of these tools integrated with the action research process, and thought out with the members of the organization. Thus, researchers had to be skillful about capturing not only the collection of data but also feelings, anxiety, suspicion, hostility, to increase the success of the study, like the perceptions of the chef, investors, and staff about the implementation of a new creational process.

(7) *Action research requires a breadth of pre-understanding of the environment*: as suggested by Nonaka and Takeuchi (1995), action researchers in operations management need to know organisations' systems and the dynamics of the operation, not just go out into the field. In this sense, researchers used their academic and professional background to bring relevant contribution to the pre-understanding of the environment and used, also in Part I phase ii, the mapping and observation as tools to know the dynamics of the operation;

(8) *Action research should be conducted in real-time*: although action research is traditionally a live case study, it can also assume the form of a retrospective formal case study. The written case is used as an intervention promoting the learning process in the organisation, as proposed in the framework and the expected outcomes;

(9) *Action research requires an understanding of the ethical framework*: address a key operational aspect of the research involving the relationship between researchers and members of the organisation. It was observed during the pre-study of the organisation, and along with all the phases of the study;

(10) *The action research paradigm requires its quality criteria*: Reason and Bradbury (2001) pointed out questions for quality in action research. From the perspective of developing a praxis of relational participation, the research involved the stakeholders during the process of building a solid infrastructure for the organisation. The iterative process of training, implementation, discussing, and gathering feedbacks created an inclusive and welcoming environment for stakeholders' reflections, which was essential for the success of the research.

The entire investigation process took six months to be completed, corresponding to an entire cycle of three creational processes in the selected restaurant, from product conceptualisation to customer feedback. The application of the three methods explains the selection of three creational processes: Harrington's Culinary Product Development Model, Michelin-starred model, and LPPD model.

We selected an Asian-American fusion restaurant, located in Sao Paulo – Brazil, which has the concept to serve, on top of the regular menu, a monthly variable menu. This type of *fast-moving* and the *fast-changing* menu is adequate for our research purpose because, in practice, the innovation, product release, and market evaluation process occur at least 12

times per year. Among all the items in the restaurant's menu, we selected the burger because the concept of this dish: composed by several *sub-assemblies* like the bun, the burger, topping, cheese, sauce, vegetable, is very close to the concept of the innumerable components to manufacture a car. Details of each phase with some discussions of respective findings are considered in the following items.

4. Results

4.1 Results of part I – interviewing and mapping

The first step of this research consisted of semi-structured interviews with the chef in charge of a restaurant's creation and the operations manager, who are also the owners and partners of the restaurant. The chef had formal education in gastronomy and worked for famous restaurants in Brazil, including the only two-star Michelin restaurant in the city of Sao Paulo until 2017 (The Michelin Tire Corporation 2017). Also, he is a professor at a gastronomy school and investor in other restaurants and burger shops in the city. His partner at the Asian-American fusion restaurant has formal education in business. He worked in the automotive industry in finance and marketing areas. He is the manager in charge of operations, finance, and administration of the restaurant.

Each semi-structured interview took about 90 to 120 minutes and was performed at the interviewee's place of business. The interviews had the objective to gather information regarding the experiences of the interviewed persons, to understand their current practice of innovative product development, as well as the current process of menu and dishes creations. Additionally, in this interview, we tried to capture intangible and essential aspects of the creational process: like their inspiration source, their influences, style of the chefs, which may contribute to our research in further steps.

We analysed the content of the interviews using VOS Viewer content analysis software to find a response pattern, as well as to identify the recurrent terms and concepts in the dining innovation process. We also reviewed the transcribed interview and responses in order to elaborate on a *road map* or process flow of the innovation process in the restaurant. This step was essential to sketch the process, which was further confirmed through the observation on the actual floor.

The interviews were essential to draw the flow of product creation but also to note that in the concept, idea, and supplier search phase, the chef mentioned focus on concept, customer's *experience*, and *happiness* while the manager focused on costs, processes' stability and training. Both said that the following phase, *trial, and error* concentrates on *the main conflicts between the creational process and the controlling process*.

The observation and mapping process consisted of the record of the situation before the implementation of new processes, which can be considered the as-is situation. It was divided into two main sub-processes, according to the stage of the product development process. First, related to the conception, creative process, trial, error, and testing, which occurs outside the restaurant environment, usually at the Chef's residence. Moreover, the second one, which is composed of the trial and error, production preparation, training product launching, and product sales and feedback process.

For the first sub-process record, we collected samples of recipes and registered the trial and error process performed by the chef. A recipe book drafted by the chef was also observed, aiming to find relevant inputs for our process mapping. We accompanied the chef in some dinners and shopping at food markets, to observe how the creational process of chefs receive interesting inputs interacting with other environments. This process was inspired in the study made by Ottenbacher and Harrington (2007, p.449) in which *visiting colleague's restaurants* was identified as the most popular source of ideas, according to Michelin-starred chefs, and *Visiting food markets* was also mentioned as one of the inspiration sources.

The current creational process of the restaurant is very similar to the one prescribed by Ottenbacher and Harrington (2007) Michelin-starred process. Table 1 summarises the current adherent practices.

Table 1: Adherence to current operation with Michelin model

Concept			Currently Applicable?	Comments
Michelin Development	1. Idea Generation	1.1. Product Consideration	Yes	- Food product is the basis of strategy and idea. For example, chef keeps strong ties with "Canastra" famous cheese producer in São Paulo, Brazil. - Creativity skills based on seasonal products and Japanese / American sports theme influence (e.g. ingredients from the city of Word Series champion)
		1.2. Inspiration Sources	Yes	
		1.3. Tacit Creativity Skills	Yes	
	2. Screening	2.1. Screening Criteria	Yes	Seasonality of products, quality, fit with cooking style (Chef's specialty are meats), cost (controlled by operations manager), were observed.
	3. Trial and Error	3.1. Cooking in your head	Yes	Individual parts of the creation are intensively tested. There is an image training of the harmonization and presentation. Though, *amuse guele* (free appetizer) practice is not common.
		3.2. Giving it a shot	Yes	
	4. Concept Development	4.1. Informal Market Research	Yes	Informal market research performed through visits. Concept is not formalized utilizing recipe date file. Operational issues and differentiation factors (presentation, for example) are developed.
		4.2. Formalize Concept	**No**	
		4.3. Differentiation Factors	Yes	
		4.4. Operational Issues	Yes	
	5. Final Testing	5.1. Operational Issues	**No**	Although operational issues are mapped in previous stages, during the test they are not performed. Multiple sources of testing involves partners, trustful employees. Customers are not considerer in the process.
		5.2. Multiple Sources of Testing	Yes	
	6. Training	6.1. Operational Issues	Yes	Training occurs, but interviewees recognize that training time should be longer than current the current one.
		6.2. Communication & Testing	Yes	
	7. Retail	7.1. Assessment - Satisfaction	**No**	A target sales quantity is fixed and popularity is measured by achievement of target. Customer satisfaction in not measured formally, just a tacit knowledge.
		7.2. Assessment - Popularity	Yes	

Like the outcomes suggested by Ottenbacher and Harrington (2007), the success of the process comes from the chef's tacit skills. Thus, essential processes of knowledge management, storage, and formalisation are weak. This process is twofold: while the chef in charge gains agility in the development process, the knowledge basis is not shared among key per-

sons in the business, which interferes negatively in the innovation process. Thus, from the mapping process, it was possible to assess that the model proposed by Harrington (2004) *culinary product innovation process* had low applicability to the case studied, mainly due to the following factors:

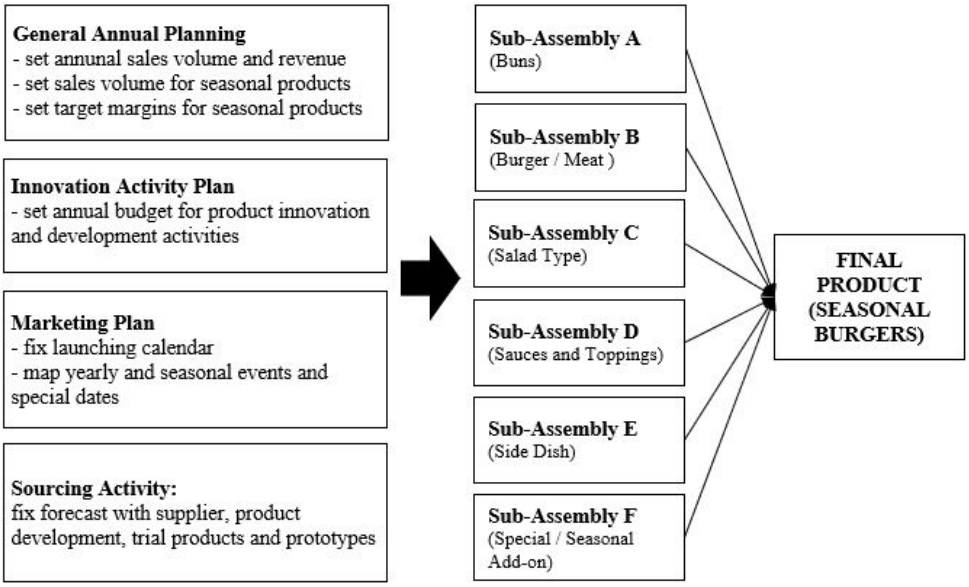
- As for internal factors, the process to select and conduct the team is unfeasible, especially in the following aspect: *the culinary innovations team in a real-time setting will be involved in every phase of the process and closely tied to continuing daily operations* (Harrington 2004), because the extraordinarily fast-moving and fast-changing menu, and the human resource constraints, create barriers for activities allocation;
- According to the chef and his partner, the culinary innovation formulation as the preliminary step of this model is very *difficult to implement*, because the short lead time required to develop a new product (maximum two months in the case) is not sufficient to adequately capture external environment variables like seasonality, regulations, competitors' actions, customer preferences, in a participative and iterative way as prescribed by Harrington's (2004) work. The process relies more upon a sequential process, usually centered in the figure of the chef;
- The same happens with other processes, *which seems to be more appropriate for businesses with a larger scale developing serial products* according to the chef and partner-manager.

Finally, as one last outcome from the mapping process, it was possible to define the six *patterns of sub-assemblies* and development flow of each component of the seasonal burger, which is detailed in Figure 4.

For each sub-assembly of the final product (burger components), the chef in charge, the partner-manager, and the operations manager oversee the product development. The product-launching calendar is shared and discussed with each sub-assembly supplier in advance, so that those suppliers can have sufficient time for their development process. For example, the restaurant shares the product-launching calendar, which can include commemorative menus and seasonal thematic burgers. The supplier, in turn, prepares a basket of products, for example, a variety of cheese blends, which are candidates to match the seasonal product launchings. This practice favours the chef's creational process, giving him the flexibility to make different combinations as well as providing sources of inspiration.

However, some processes, which are very common in the LPPD, and Process Development, were missing. Because the innovation process of the restaurant relies on the tacit knowledge of the chef, the level of formalisation is deficient. For example, the catalogue of main suppliers for each sub-assembly was not available; there was not a database registering developed and underdevelopment sub-assemblies (for example, a sauce list, a list of cheese blends). Thus, although the criteria to select the best combination of ingredients (sub-assemblies) occur in order to maximise customer satisfaction and stable profitability, the entire process lacks formal procedures and methodology, meaning that an essential part of the value capturing may be lost. For example, in the case of sub-assembly 'B' (Burger / Meat) the selection criteria of the best meat blend and receipt were not uniform, and not in alignment with the objectives of that product (i.e., prepare a burger which lowers the bottle necks in the production process through reduction of the grilling time).

Fig 4: Sub-Assemblies and sourcing activities



Such aspects were explored during the second part of the research, where we provided theoretical and practical training of product creation and innovation process based on the work of Ottenbacher and Harrington (2007) and the LPPD model. The training was followed by the observation of the process, implementation, and feedback activity.

4.2 Results of part II – training, observation, and feedback

These steps consisted of the instruction and training of innovative product creation process based on three approaches: LPPD product development processes according to the literature and as shown in Figure 1; Culinary Product Development approach as shown in Figure 2 and proposed by Harrington (2004), and Michelin-starred process as proposed by Ottenbacher and Harrington (2007). The primary purpose of applying those product development approaches to the creative process of our sample was to observe how chefs, managers, and employees would react when a new process is introduced. Therefore, we aimed to observe if successful cases of those creational process would improve the performance of the restaurant, concerning product development lead-time, quality improvement, and customer value creation improvement.

The literature of action research proposes that working collaboratively with others leads to community and organisational changes in which participants grew to appreciate how their interrelatedness creates a power greater than a sum of individual powers (Kasl and Yorks 2002; Reason and Bradbury 2001). In this study, the training activity took four hours, divided into two hours of theoretical training (seminar format) in which every staff of the restaurant learned the basic concepts of Michelin-starred creational process and Culinary Product Development, as well as LPPD model. One-hour *hands-on training* consisted

of self-evaluation of the current creation, production, and customer service process, in which every employee was encouraged to revise his process and propose efficiency improvements. Finally, a one hour feedback session was promoted, where employees, chefs, owners, and researchers discussed the results, findings, and contributions of the activity.

The feedback activity was recorded, in order to support the construction of the mapping process in the following step, and gathered directly from the chef and the manager, through social communication application. Interesting points to note from this phase were the opinion of the owner-chef contrasted with those of the manager. For the first, *such a formal process is sometimes challenging to apply in the actual floor, especially in our business, where we have to be very agile in the creational process. I believe that the customer demands novelties and seeks new gastronomic experiences. Of course, a well-prepared classic is essential, but the novelty is the key to have your business in evidence in a fast-moving market like the one we are experiencing, while for the second, introducing established concepts from other industries will always bring some positive contribution. In our business, we are informal with processes, and innovation usually wastes too much time with the trial and error process*.

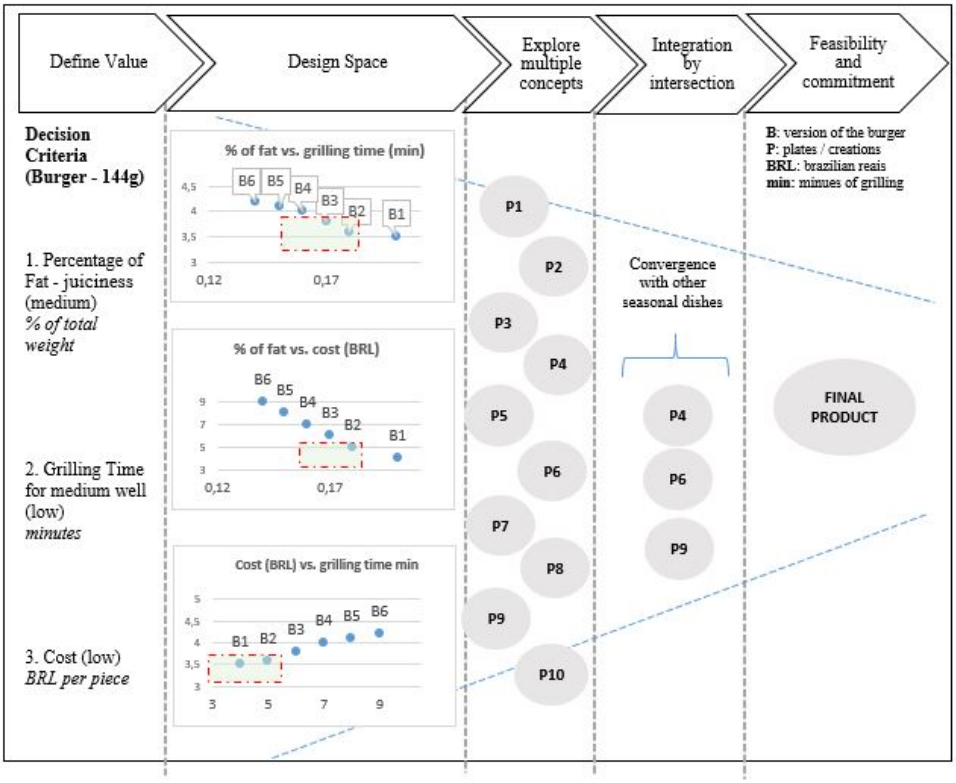
Also, we compare the perceptions, pros, and cons, of Michelin chef's creational process, Culinary Product Development model, and LPPD model from owner-chef and owner-manager point of view. Table 2 summarises the perception of the product development model from the owner-chef and owner-managers point of view. During the process mapping works, it was stated that concepts like *knowledge-based environment*, *continuous improvement*, and all principles of SBCE except *define* value were not adopted. Still, after the implementation of *to-be* process based on LPPD and the presentation of positive achievements, the owner-chef showed concerns about the *knowledge-based environment* and *feasibility and commitment* concepts, believing that both practices would slow down the product development process and consequently lose the timing of new launches.

Table 2: Introduction of LPPD – adherence, and comments

Concept / Principle			Reference	Existing during as-is mapping?	Owner-Chef	Owner / Operations Manager
					Favorable for implementation	
1. LPPD	1.1	Value Focus	Khan et al (2011)	Yes	Yes	Yes
	1.2	Knowledge-Based Environment	Maksimovic et al. (2014)	**No**	Neutral	Yes
	1.3	Continuous Improvement	Mohd Saad et al. (2013)	**No**	Yes	Yes
	1.4	Chief Engineering	Al-Shaab et al. (2013)	Yes, owner chef as "Shusa"	Yes	Yes
	1.5. SBCE	Define Value	Morgan and Liker (2006) Sobek et al. (1999) Ward et al. (1995) Ward (2007)	Yes	Yes	Yes
		Design Space		**No**	Yes	Yes
		Explore Multiple Concepts		**No**	Yes	Yes
		Integration by Intersection		**No**	Yes	Yes
		Feasibility and Commitment		**No**	**No**	Yes

During the training process, it was also possible to create an overall approach using Trade-off Curves (ToC) within the SBCE model, as shown in Figure 5.

Fig 5: ToC within SBCE approach



In this example, the step called *Define Value* aligned the product development with company strategy and tentatively translated customer value to the product. Once those values are fixed, the product developers moved to the *Design Space* step, where essential characteristics of the product and which improvements on those characteristics were needed. Then, developers defined a feasible region, called product acceptance area, in order to select the best product. Considering the selected values of percentage of fat, grilling time and cost, product B2 was the only suitable for the project because the intersection of attributes will increase the possibility of customer satisfaction (taste of the product – juiciness of the meat), efficiency in the preparation time (best grilling time) and profitability (lower cost).

As mapped during the phase I mapping process, the annual plan sets the target indicators and targets for each launch. In the studied case, the product had to improve the grilling time (due to some workforce and training time constraints), achieve better profitability compared with other seasonal products planned for the year (because the launch month has a historically lower volume of sales). Finally, from the *technical* point of view, the meat had to achieve an appropriate percentage of juiciness to harmonise with other sub-assemblies. Therefore, the percentage of fat in the meat blend must be introduced precisely.

The following step, called *Explore Multiple Concepts*, consisted on combining the selected burger type (B2) with other innovative sub-assemblies, as shown in Figure 4, such as buns, salad type, and sauce type, to finally propose a basket of product alternative which we called P's (P1 to P10). Then, in the *Integration by Intersection* phase, the development team proceeded with the evaluation of this first basket of developed products, in order to look for intersections or convergences with other seasonal dishes in the restaurant's menu, seeking for synergy gains in the sourcing and production. A final set of three plates (P4, P6, and P9) formed the set of final products, finally moving to the *Feasibility and Commitment* phase. In this final phase, the final specification of the product is defined as satisfying customer requirements and decision criteria. Furthermore, the knowledge stored during the entire decision process could be reused in future projects; hence, discarding knowledge would be prevented.

Observation and mapping aim to observe the real operation running after the training of chefs, managers, and employees. Unlike the previous *Observation and Mapping*, Part II consisted of the record of the situation after the implementation of new processes, which aims to achieve the *to-be* situation trained in the previous step. As presented in Figure 3, we promptly discarded the *Culinary Product Innovation Process* due to the lack of adherence processes, and therefore advanced with the application of the *Michelin product development* process and LPPD model. Each model demanded two months of a development cycle. The chef's creational process was observed and registered, so it is compared with the creational process before the training session and therefore processes efficiency gains, as well as improvements in customer value. The same process was conducted with trial and error, production preparation, training product launching, and product sales and feedback process.

For the results compilation process, we analyse the lead time of a creational process, from the first idea generation until the filing of customer feedback (if there are any); which is measured in days and divided into the several steps involving the development of a new product in the food service business. Improvement in the process is perceived when the restaurant can reduce the total days demanded to create a new dish and reduce the waste. In terms of lead-time improvement, it was possible to reduce by eight days in the conceptualisation and formation of the idea for a new dish, through the reduction supplier search process. The lead-time reduction considered the actual lead-time of the restaurant, which was more similar to the Ottenbacher and Harrington (2007) Michelin model versus the new model proposed by LPPD.

The maintenance of a knowledge basis regarding under-development dishes, as explained during the Training phase, allowed the chef and operational manager to optimise the combination of ingredients in the best season available. Part of the gain in the total lead-time, four days, was converted to the production preparation and training process, which was one of the owners' concerns. However, it is essential to mention that the eight-day reduction was not entirely a result of the introduction of LPPD. Since we conducted the LPPD experiment after the two-month development cycle of the Michelin model, some gains from the improvement of the knowledge curve should be considered.

Finally, as for the Culinary Production Development Model, despite the relevant work of Harrington (2004), the application in our concrete case showed that in business with a smaller scale, which at the same time requires more dynamic responses and sometimes in-

formal practices, the adherence is low. For example, prescriptions of *Planning and Linking Process* like *food safety and dietary issues, regulations, culinary identities, consumer research* are not performed by the book: it occurs in such a small scale and intensity that is implicitly executed during other activities of the product development process.

5. Discussion and considerations

In this work, we aimed to investigate if it is possible for restaurant owners and chefs to implement innovative processes and product development based on consolidated practices such as LPPD. Moreover, if it is possible to identify similarities in the product development process of renowned chefs, like Michelin-starred chefs, and LPPD approaches. Our findings suggest that the Michelin chef's creational process is the closest and most adherent model for small to medium size scaled restaurants, with a high frequency of seasonal products launched during a year, but with the prominent possibility to introduce good practices from LPPD model.

In the list of adoptable practices, we can include the improvement of the product development process through the implementation of SBCE practice, as shown in the *training*, *observation*, and *feedback* section. It includes the preparation of decision flow based on Trade-Off Curves (ToC's), definitions of values, analysis of intersections, and creation of a product development knowledge database in order to improve the concurrent engineering process of the menu. From the outcomes of our action research, we propose that SBCE can be the ideal enabler to start the introduction of LPPD model in the culinary innovation, because despite the uniqueness of the developed product (artisanal culinary product), the concept of sub-assemblies and assemblies, which is present in the industrial production, the process is similar. We could note the adoption of concepts like Trade-off curves and the analysis of different intersections of feasible sets of products, as described in Figure 5. Therefore, the five SBCE principles proposed by Kahn et al. (2011) and described in section 2.1 can be applied to decide on a product based on avoidance of educated guesses, and grounded on a knowledge base gained from simulations, prototyping, and tests. Other LPPD principles such as Value Focus (VF), Knowledge-Based Environment (KBE), Continuous Improvement (CI), and Chief Engineer (CE) were noticed during the action research, though we could not collect sufficient evidence in the application of those concepts. For example, the Chief Engineer (CE) role could be attributed to the restaurant's chef, because he is responsible for technical leadership throughout the entire product development process. Though the chef does not consciously recognise this function, nor does he have the interest to assume such responsibility. This lack of self-consciousness is a thick barrier to be surpassed before considering this enabler as fully adopted by the restaurant.

Value Focus (VF), which has the objective to increase the value of the process through the satisfaction of stakeholders' expectations, is performed at an informal level, as perceived on the statements of the chef and operations manager during the interviews, as explained in our *training, observation and feedback* section. In sum, the necessity to be dynamic and agile in the development process imposes an obstacle to introducing 'less practical and tangible' tools, which will not bring concrete and immediate outcomes. The same

notion is perceived in the enablers Continuous Improvement (CI) and Knowledge-Based Environment (KBE). Therefore, the application of those principles in the culinary innovation process is highly recommended for further studies.

The expanded meaning of this action research, in addition to its immediate context, is to introduce into the 'extremely chef-centered' gastronomic industry, the participative element of listening, and considering the other in a process. There are several reality shows that demonstrate this autocratic social system in gastronomic environments, and as the action research introduces the portion of the interaction of voices, and all validated by experimentation, it ceases to focus only on opinion and validate by evidence.

In turn, in the most immediate element, the signifier is to introduce structured experimentation combined with the record of objective data, but also the fundamental tacit knowledge in gastronomy. It also covered social relevance because the research improves knowledge about people, communities, cultures, and people as agents.

The adoption of new tools and consolidated practices from car manufacturing by the chef, manager, investors and restaurant's employees: in other words, the changing process of the organisation practices, was grounded in an interactive, co-operative, and integrative approach which allowed to introduce new and enduring 'infrastructures' in the organisation. Thus, even not adopting other LPPD principles allowed the organisation to create a self-evaluation culture to evaluate its organisational processes continually. These outcomes aligned with what Reason and Bradbury (2001) point out to be choice points and questions for quality in action research.

Limitations of this work consist of the size and location of the business, as well as the action research duration, which considered three complete product development cycles. Distinct culinary styles in other locations may bring different outcomes. Thus, increasing the number of product development cycles may influence the learning curve of the participants, which may also lead to distinct conclusions.

Finally, this work opens the way to creating a new Product Development Model focusing in the food service industry, a hybrid model, which can concatenate the agile and dynamic practice of using the tacit skills and knowledge from renowned chefs with the precise and sober process of the manufacturing industries relying on LPPD principles.

References

Al-Ashaab, A. & Sobek, D., (2013). Lean product and process development: a value creation paradigm that goes beyond lean manufacturing. *International Journal of Computer Integrated Manufacturing*, pp. 1103-1104. Doi: 10.1080/0951192X.2013.834483

Al-Ashaab, A. et al., (2016). Development and application of lean product development performance measurement tool. *International Journal of Computer Integrated Manufacturing*, 29 (3), pp. 342-354. Doi: 10.1080/0951192X.2015.1066858

Antony, J., Rodgers, B. & Elizabeth, C., (2017). Lean Six Sigma for public sector organizations: is it a myth or reality?. *International Journal of Quality & Reliability Management*, 34(9), pp. 1402-1411. Doi: 10.1108/IJQRM-08-2016-0127

Antony, J., Rodgers, B. & Gijo, E., (2016). Can Lean Six Sigma make UK public sector organisations more efficient and effective?. *International Journal of Productivity and Performance Management*, 65(7), pp. 995-1002. Doi: 10.1108/IJPPM-03-2016-0069

Baines, T., Lightfoot, H., Willians, G. & Greenough, R., (2006). State-of-the-art in lean design engineering: a literature review on white-collar lean. Proceedings of the Institution of Mechanical Engineers, Part B: *Journal of Engineering Manufacture*, 220(9), pp. 1539-1547. Doi: 10.1243/09544054JEM613

Bowen, D. & Yiungdahl, W., (1998). "Lean" service: in defense of a production?line approach. *International Journal of Service Industry Management*, pp. 207-225. Doi: 10.1108/09564239810223510

Brydon-Miller, M., Greenwood, D. & Maguire, P., (2003). Why Action Research?. *Action Research*, 1(1), pp. 9-28. Doi: 10.1177/14767503030011002

Chattopadhyay, N. & Shah, M., (2014). Exploring the effect of service innovation on business performance of restaurants in India. *International Journal of Business Innovation and Research*, 8(3), pp. 252-264. Doi: 10.1504/IJBIR.2014.060827

Cho, M., Bonn, M., Han, S. & Kang, S., (2018). Partnership strength and diversity with suppliers: Effects upon independent restaurant product innovation and performance. *International Journal of Contemporary Hospitality Management*, 30(3), pp. 1526-1544. Doi: 10.1108/IJCHM-01-2017-0016

Coghlan, D. & Brannick, T. (2001). *Doing Action Research in Your Own Organization*, Sage, London.

Comm, L. C. & Mathaisel, F. D., (2003). A case study in applying lean sustainability concepts to universities. *International Journal of Sustainability in Higher Education*, pp. 314-323. Doi: 10.1108/14676370510589855

Cooper, R. G., (1990). Stage-gate systems: a new tool for managing new products. *Business Horizons*, pp. 44-54. Doi: 10.1016/0007-6813(90)90040-I

Cooper, R. G., (1993). *Winning at New Products: Accelerating the Process from Idea to Launch*. New York: Addison-Wesley.

Cooper, R. G., (2008). Perspective: the stage-gate idea-to-launch process – update, what's new, and NexGen System. *Journal of Production Innovation Management*, 25(3), pp. 213-232. Doi: 10.1111/j.1540-5885.2008.00296.x

Coughlan, P. & Coghlan, D. (2002). Action research for operations management. *International Journal of Operations & Production Management*, 22 (2), pp. 220-240

Delgado, C., Ferreira, M. & Branco, M., (2010). The implementation of Lean Six Sigma in financial services organizations. *Journal of Manufacturing Technology Management*, 21(4), pp. 512-523. Doi 10.1108/17410381011046616

Drotz, E. & Poksinska, B., (2014). Lean in Healthcare from Employees' Perspectives. *Journal of Health Organization and Management*, 19(3), pp. 177-195. Doi: 10.1108/JHOM-03-2013-0066

Farrington, T., Antony, J. & O'Gorman, K. D., (2018). Continuous improvement methodologies and practices in hospitality and tourism. *International Journal of Contemporary Hospitality Management*, 30(1), pp. 581-600. Doi: 10.1108/IJCHM-03-2017-0141

Fuller, G., (2011). *New Food Product Development*. Boca Raton: CRC Press.

Grönlund, J., Sjödin, D. R. & Frishammar, J., (2010). Open Innovation and the Stage-Gate Process: A Revised Model for New Product Development. *California Management Review*, pp. 106-131. Doi: 10.1525/cmr.2010.52.3.106

Gummesson, E. (2000). *Quantitative Methods in Management Research*, 2nd ed, Sage, Thousand Oaks, CA.

Harrington, R., (2004). Part I: The Culinary Innovation Process – A Barrier to Imitation. *Journal of Business Research*, 7(3), pp. 35-56. Doi: 10.1300/J369v07n03_04

Hébert, R. & Link, A., (2006). The entrepreneur as innovator. *The Journal of Technology Transfer*, 31(5), pp. 589-597. Doi: 10.1007/s10961-006-9060-5

Karlsson, C., & Åhlström, P. (1996). Assessing Changes Towards Lean Production. *International Journal of Operations & Production Management*, 16(2), 24-41. Doi: 10.1108/01443579610109820

Kasl, E. & Yorks, L., (2002). An Extended Epistemology for Transformative Learning Theory and Its Application Through Collaborative Inquiry.

Khalil, R. & Stockton, D., (2010). Predicting the effects of cycle time variability on the efficiency of electronics assembly mixed-model, zero buffer flow processing lines. *International Journal of Computer Integrated Manufacturing*, 23(12), pp. 1149-1157. Doi: 10.1080/0951192X.2010.500679

Khan, M. et al., (2011). Set-Based Concurrent Engineering process within the LeanPPD environment. In: *Advanced Concurrent Engineering*. London: Springer, pp. 433-440.

Krafcik, J. F., (1988). Triumph of the Lean Production System. *Sloan Management Review*, pp. 41-52.

Lee, C., Hallak, R. & Sardeshmukh, S., (2016). Innovation, entrepreneurship, and restaurant performance: A higher-order structural model. *Tourism Management*, Volume 53, pp. 215-228. Doi 10.1016/j.tourman.2015.09.017

Lee, C., Sardeshmukh, S. & Hallak, R., (2018). Understanding the innovation development process in restaurants SMEs. In: *CAUTHE 2018: Get Smart: Paradoxes and Possibilities in Tourism, Hospitality and Events Education and Research*. Newcastle: NSW: Newcastle Business School, The University of Newcastle, pp. 121-134.

Leite, H. R. & Vieira, G. E., (2015). Lean philosophy and its applications in the service industry: a review of the current knowledge. *Production*. Doi 10.1590/0103-6513.079012

Levitt, T., (1972). Production-line approach to service. *Harvard Business Review*, 50(5), pp. 20-31.

Levitt, T., (1976). The industrialisation of service. *Harvard Business Review*, 54(5), pp. 32-43.

Liker, J. K., (2004). The Toyota Way: *14 Management Principles from the World's Greatest Manufacturer*. New York: McGraw-Hill.

Middleton, P., (2001). Lean software development: two case studies. *Software Quality Journal*, Volume 9, pp. 241-252. Doi 10.1023/A:1013754402981

Mishra, V. K., (2016). Product development strategies. In: *Dairy Processing and Quality Assurance*. New Jersey: John Wiley & Sons, pp. 488-505.

Monden, Y., (2011). *Toyota Production System: an Integrated Approach to Just-In-Time*. 4th edition ed. Hoboken: CRC Press.

Morgan, J. & Liker, J., (2006). *The Toyota product development system: integrating people, process, and technology*. New York: Productivity Press.

Nadler, D (1998). *Champions of Change*, Jossey-Bass, San Francisco, CA.

Nonaka, I. & Takeuchi (1995). *The Knowledge-Creating Company*, Oxford University Press, New York, NY.

Oosterwal, D., (2010). *The lean machine: how Harley-Davidson drove top-line growth and profitability with revolutionary lean product development*. New York: AMACOM American Management Association.

Ottenbacher, M. C. & Gnoth, J., (2005). How to develop successful hospitality innovation. *Cornell Hotel and Administration Quarterly*, 46(2), pp. 205-222. Doi 10.1177/0010880404271097

Ottenbacher, M. & Harrington, R., (2007). The innovation development process of Michelin-starred chefs. *International Journal of Contemporary Hospitality Management*, 19(6), pp. 444-460. Doi: 10.1108/09596110710775110

Ottenbacher, M. & Harrington, R., (2009). The product innovation process of quick?service restaurant chains. *International Journal of Contemporary Hospitality Management*, 21(5), pp. 523-541. Doi: 10.1108/09596110910967782

Pich, M., Loch, C. & Meyer, H., (2002). On uncertainty, ambiguity and complexity in project management. *Management Science*, 48(8), pp. 955-1101. Doi: 10.1287/mnsc.48.8.1008.163

Poksinska, B., Fialkowska-Filipek, M. & Engström, J., (2017). Does Lean healthcare improve patient satisfaction? A mixed-method investigation into primary care. *BMJ Qual Saf*, pp. 95-103. Doi: 10.1136/bmjqs-2015-004290

Pyne, A. W., (2000). Innovative new food products: Technical development in the laboratory. In: *Developing new food products for a changing marketplace*. Boca Raton: CDC Press, pp. 259-275.

Reason, P. & Bradbury, H.(eds.) (2001). *Handbook of action research: Participative inquiry and practice*. London: Sage Publications.

Rice, M., O'Connor, G. C. & Pierantozzi, R., (2008). Implementing a learning plan to counter project uncertainty. *MIT Sloan Management Review*, 49(2), pp. 54-62. Doi: 10.1109/EMR.2008.4534821

Rudolph, M. J., (1995). The food product development process. *British Food Journal*, 97(3), pp. 3-11. Doi: 10.1108/00070709510081408

Schonberger, R., (1994). *Building a chain of customers*. New York: The Free Press.

Shenhar, A., (2001). One size does not fit all projects: exploring classical contingency domains. Management Science, 47(3), pp. 394-414. Doi: 10.1287/mnsc.47.3.394.9772

Shingo, S. & Dillon, A. P., (1989). *A Study of the Toyota Production System: From an Industrial Engineering Viewpoint*. New York: Productivity Press.

Smith, M., Paton, S. & MacBryde, J., (2017). Lean implementation in a service factory: views from the frontline. *Production Planning & Control*, 29(4), pp. 280-288. Doi: 10.1080/09537287.2017.1418455

Sobek, D. K., Ward, A. C. & Liker, J. K., (1999). Toyota's principles of set-based concurrent engineering. *Sloan Management Review*, pp. 67-84.

Stewart-Knox, B., Mitchell, P., Bunting, B. & Parr, H., (2003). A model for reduced-fat food product development success. *Food Quality and preference*, 14(7), pp. 583-593. Doi: 10.1016/S0950-3293(02)00152-0

Swank, C., (2003). The lean service machine. *Harvard business review*, 81(10), pp. 123-130.

Tay, H. L., (2016). Lean Improvement Practices: Lessons from Healthcare Service Delivery Chains. *IFAC-PapersOnLine*, 49(12), pp. 1158-1163. Doi: 10.1016/j.ifacol.2016.07.660

The Michelin Tire Corporation, (2017). *Michelin Red Book*. Ferrand: Michelin et Cie.

Trott, P., (2005). *Innovation Management and New Product Development*. Harlow: Pearson Education Limited.

Utterback, J. M., (1971). The process of technological innovation within the firm. *Academy of Management*, 14(1), pp. 75-88. Doi: 10.2307/254712

Vashishth, A., Chakraborty, A. & Antony, J., (2017). Lean Six Sigma in financial services industry: a systematic review and agenda for future research. *Total Quality Management & Business Excellence*, pp. 447-465.Doi: 10.1080/14783363.2017.1308820

Vinodh, S., (2018). Application of Structural Equation Modeling for Analysis of Lean Concepts Deployment in Healthcare Sector. *Progress in Lean Manufacturing*, pp. 91-103. Doi: 10.1007/978-3-319-73648-8_4

Ward, A. C., (2007). *Lean product and process development*. Cambridge: Lean Enterprise Institute.

Ward, A. C. & Sobek II, D., (2014). *Lean Product and Process Development*. 2nd edition ed. s.l.: Lean Enterprises Inst Inc.

Ward, A., Liker, J. K., Cristiano, J. J. & Sobeck, D. K., (1995). The Second Toyota Paradox: How Delaying Decisions Can Make Better Cars Faster. *Sloan Management Review*, 36(3), pp. 43-61.

Westbrook, R. (1993). Orderbook models for priority management, a taxonomy of data structures. *Journal of Operations Management*, 11(2), pp. 123-42 Doi: 10.1016/0272-6963(93)90019-L

Wheelwright, S. C. & Clark, K. B., (1992). *Revolutionizing product development: quantum leaps in speed, efficiency, and quality*. Cambridge: Harvard Business School Press.
Womack, J. P., Jones, D. T. & Ross, D., (1990). *The machine that changed the world*. New York: Rawson Associates.

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