Using SCRUMBAN methodology for Production Planning and Control in Luxury/Fashion Manufacturing Companies

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Abstract

Operations planning and control has long been dealt with in many ways, mostly with mathematical and analytical approaches. These approaches work properly at a high level, but they have not proved suitable at the shop floor level, where, in order to cope with frequently emerging problems, what managers need is detailed information concerning the level of Work In Process (WIP) and the actual load of both equipment and resources. This issue is particularly evident in the luxury/fashion market, where, due to the continuous and rapid changes in fashions' trends and to the need to interface with dozen of suppliers, reactivity is vital and managers are urged for planning and analysis tools that are extremely simple and easy to use. In this regard, SCRUMBAN, a recently introduced Visual Management technique, which integrates SCRUM (a widely adopted project planning technique in the software field) with Kanban, is emerging as a powerful way to control WIP, visualize loads, synchronise internal and external flows and, lastly, to motivate people. In response to a gap in the technical literature the paper focuses on this topic with the following objectives: (i) analyse the main characteristics of the SCRUMBAN technique, (ii) propose an original methodology and a structured framework for the development of this technique in the manufacturing field and (iii) provide a guideline for the application of the instrument in the luxury/fashion sector. The last point is addressed through a real case-study, developed in an Italian fashion firm, which gave outstanding preliminary results.

Keywords: Production Planning and Control, Luxury/fashion supply chain, SCRUMBAN, WIP Control

1. Introduction

Nowadays, companies operate with a common pattern: globalization, continuous technology development and constant and progressive change of customer's needs (Laosirihongthong and Dangayach, 2005). These variables push the global industry to be dynamic and flexible, to reduce wastes, to find a good costs-quality-time trade-off and, finally, to find another way of operating (Dangayach and Deshmukh, 2003). Strategy should be dynamically revised and updated, through a combined and continuous analysis of both the company's external and internal environment, with the aim of identifying technological, economic, social and politic changes and by comparing them with core competencies and with the available production capacity (Acosta and Rodriguez, 2008). The objective is, in fact, to identify the existing gap and fill it as soon as possible from the strategic to the operating level; not reacting to these factors can only mean low profits or, in the worst case, the failure (Voss, 1995; Li and Tan, 2004; Raymond and Croteau, 2006).

Starting from the last decades of the 20th century, Lean Production has emerged as a possible answer, encompassing principles of flexibility, agility, workers' motivation and exploitation. Lean Production (Shah and Ward, 2007), is made of a mix of principles, methods and techniques for operations management, whose main goals are to maximise the perception of the end customer's value and to minimise wastes, systematically.

Implementing lean is not straightforward, and many obstacles must be overcome, especially at the shop floor level, where production planning and control are the most critical areas. Many

instruments can be used to plan and control activities, but most of the times they do not have an adequate level of simplicity and immediacy to be of concrete help. For instance, Gantt charts could be used to properly visualize how tasks have been scheduled; yet the Gantt becomes useless if not even misleading, unless it is constantly kept up to date, anytime new orders are collected and/or unforeseen adverse events (such as failures) take place (Maylor, 2001; McKay and Black, 2007). Conversely, shop floor tools must be lean, flexible and visual: what managers and workers want is to find, immediately, the information they are looking for. Examples are the horizontal signposting or kanban cards, handon lights, projectors or screens that give a complete up-to-date view of the current situation, in terms of machines' state, production progress and Work In Progress (Suna and Kuob, 2002).

According to what stated before, developing new Visual Management techniques is emerging as a new stream of research, with huge practical impacts. The software industry has been a precursor of this innovative trend, as it readapted most of the Lean Production techniques to the software field, under the name of Lean Software Development (Poppendieck and Poppendieck (2003). Among developed techniques, Scrum is probably the most famous one (Ladas, 2008). The word Scrum comes from rugby and it is used as a metaphor to indicate a team of people who work together so that every team's player goes in the same direction, acting like a coordinated unit. The Scrum technique has originated, in fact, as a synchronisation and control framework for software development. The basic idea is to subdivide the project in fast work blocks of equal length - two weeks is the standard - called Sprints. At the end of each sprint a potentially shippable software module (i.e., functioning, tested and documented) should be released and the project can advance to the next development level. Breaking down a big project into small bricks, simplifies tasks scheduling and resources allocation and, most of all, motivate team's member to complete tasks on time and/or to report any problems in advance. In this respect the use of visual management becomes fundamental and, indeed, Scrum makes use of planning boards that are used by teams to organise and to track the progress of their work.

Recently, another agile project management technique, called Scrumban, has emerged in the field of software development. Scrumban combines different features of Kanban and Scrum (Lukasz Sienkiewicz, 2012; Ladas, 2008) and it is used when a team works on different projects and/or when a project has been assigned to different cooperating teams. The idea is to enhance the Scrum Visual Boards with the use of kanban cards that are used, as in manufacturing, to pull and to synchronize the information flows among the teams. The technique of Scrumban, in fact, uses the prescriptive nature of the Scrum and uses process improvement typical of Kanban to allow the project's teams to continually improve. Meetings for planning are carried out to define which tasks need to be completed in the next step. Tasks are then assigned to teams and added, as kanban cards, to the Visual Board, so as to visually track the project's progress and to make it explicit "who does what" (Ladas, 2008, Nikitina et al., 2012).

Due to the success achieved both by Scrum and Scrumban - see for example the work by Xiaofeng et al. (2012), who report an analysis of about thirty successful experiences of lean application in software development industry - a sort of break in the traditional trend is taking place, with lean principles that, unlike before, are exported from software development to the manufacturing field. Indeed, some manufacturers, operating especially in the make to order sector, are trying to readapt Scrum and Scrumban for a quicker production planning and for easier progress control. However, how to create ad-hoc Scrumban Boards for the synchronisation of shop floor activities is still an open question. The present paper belongs to this field of research and tries to shed light on this problem, focusing, mainly, on the Luxury and Fashion industry, where, due to the continuous and rapid changes in fashions' trends and to the need to interface with dozen of suppliers, reactivity is vital and managers are urged for planning and analysis tools that are extremely simple and easy to use.

2. Scrumban in the manufacturing field

Basically, rethinking Scrumban means designing a proper Visual Control Board to control WIP and, at the same time, to synchronize the activities performed in different departments of a manufacturing company. Briefly - as it will better clarified in Section 3 - the activities performed in each department will be represented by an adequate number of columns, where kanban cards will be inserted, so as to signal the work load of each department (i.e., WIP) and the progress of each production order. Unlike the software industry, were the development process follows a set of standard steps, in manufacturing a standard production approach does not exist. Thus, in order to ensure that Scrumban works out well also in manufacturing, there is the need to match the methodology with the specific production flow. To this aim we suggest following the step-by-step approach of Figure 1.

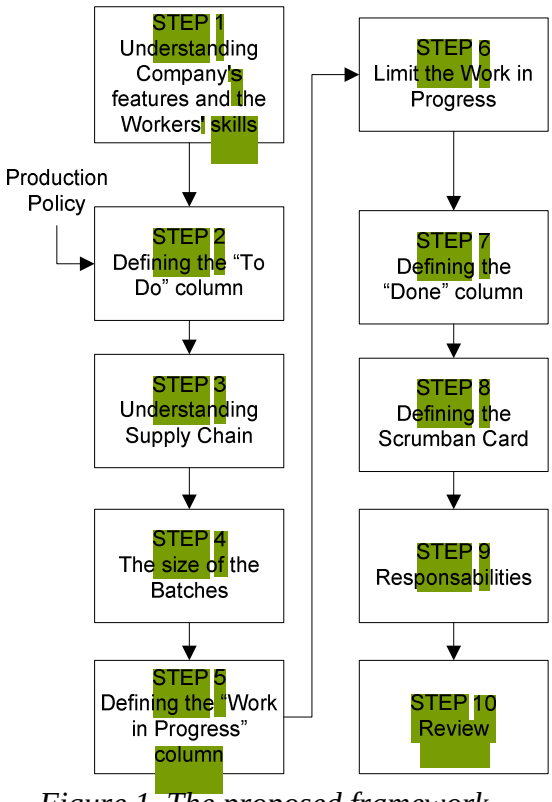

Figure 1. The proposed framework.

Step 1- Understanding Company's features and the Workers' skills

It is essential to understand the main characteristics of the firm, mainly in terms of product portfolio (single or multi item) and of production flow (flow shop or job shop). In case of high variety, complexity should be reduced, by aggregating products into families and or identifying common or similar routings among manufactured items. It is also important to get a complete picture concerning workers' skills and capabilities; the presence of multi-skilled workers, which can be used in several points of the production process, can greatly simplify the introduction of a scrumban approach.

Step 2 - Defining the To-Do column

The To-Do column - the first one of the scrumban board - is used to plan and schedule production activities. To properly design it, essential issue to be known are: *(i)* how decisions on production orders are made and *(ii)* which documents are used to keep production under control. It is also important to understand the policy followed to prioritize production lots; this allows splitting lots between backlog and priority, two additional columns of the scrumban board.

Step 3 - Understanding the Supply Chain

A detailed analysis of the supply process comes next. In this regard, it is essential to know if the company has some external suppliers (i.e., subcontractors) performing parts of the production process. If suppliers work in different stages of the process, the appropriate columns must be add to the board.

Step 4 - The Size of the Batches

This step is needed to understand, on average, how big is a production unit (i.e., the *pitch size*, using a lean terminology). This is particularly important when a production batch is part of a bigger order that the company has scheduled in smaller units, for a better balancing of the production flow.

Step 5 - Defining the WIP column

The WIP column is used to track the progress of the batches that are being processed in different point of the production process, so as to clarify "*who is doing what*". Consequently, this column should be divided into as many sub-columns as the number of manufacturing operations in which the manufacturing process (or, *value stream*, using a lean terminology) can be ideally split. To this aims, a value stream map may be of use. Another critical point concerns the definition of the production steps that are performed inside and that are outsourced. If a process can be performed either inside or outside, the relative production quotas must be defined and clearly displayed on the board.

Step 6: Limit the Work In Progress

This is the most important step: setting the maximal WIP level of the *To-Do* column, automatically defines the throughput rate and the total throughput time (or Lead Time) of the manufacturing process. In case of software applications, the logic to determinate this limit very easy. Since during each sprint each programmer can develop at most one module of the software, the WIP level (i.e., number of modules to be developed) cannot be higher than the total number of programmers.

Conversely, in manufacturing firms, this limit should depend both on customer's demand and production capacity. Specifically, the To-Do limit should correspond to the average production capacity *C*, evaluated over the scheduling time window (for example from Monday to Friday), plus some extra batches *S*, called Share of Flexibility. These extra batches should be used only in case of urgent orders and/or peaks of demand and should equal the maximal increase of capacity that can be obtained using overproduction and/or outsourcing. Obviously, if demand *D* is higher than (*C* + *S*), then the less important (*D* - *C* - *S*) orders remain pending in a backlog list (or pre-shop pool), until enough capacity is available.

The same WIP limit should also be used in the WIP column. However, in this case, the operating logic is rather different. Indeed, if everything goes as planned, orders of the To-Do column should constantly flows without interruptions along the production process. Conversely, if something goes wrong, WIP will accumulate and this will be immediately signalled by an increasing number of kanbans in the WIP column.

Step 7: Defining the Done column

Finally the *Done* column has to be structured. This column includes the final steps of the manufacturing process such as packaging and shipping. Generally, at these late steps of the process, production capacity is not an issue of concerns and so the Done column does not have any limit.

Step 8 - Defining the Scrumban Card

This step concerns the definition of the layout of the Scrumban cards (or kanbans). It is fundamental to correctly identify all data that are needed to properly track production batches. If tracking documents are already in used, they can be used as a starting point for the customization of the Scrumban Card.

The important thing is to make it standard and clear. Anybody must be able to easily understand all the information contained on the card. Also, the use of standard symbols and standard colours may be of use to visually convey most of the information contained on the card. For instance, cards should have different colours depending on the type of product and/or of defect.

Step 9 - Responsibilities

Building the board also implies the definition of a structured workflow. Indeed one needs to determine who should compile the cards at the beginning of the process, who should move the cards, and who should update the board at the end of each time period.

Step 10 - Review

At the end of the process the scrumban board must be critically reviewed. Particular attention should be given to the limits of the WIP, so as to assure a well-balanced flow of the production process. Also, to maximise the effectiveness of Scrumban, daily meetings - at the beginning of the shift - could be organized. During these meetings, the production manager uses the scrumban board to illustrate the tasks that must be completed during the day and he can collect suggestion and opinions of the workers.

3. Scrumban in Luxury/Fashion companies: a case study

In order to assess the potentialities of the Scrumban technique, the proposed methodology was applied in an important Italian luxury-fashion company, which produces top quality leather accessories. This company represents a typical Italian small craft firm that, in response to increased market competitiveness, has lately introduced innovative lean tools, to improve production and supply chain performances (Carmignani and Zammori, 2015).

3.1 Basics elements of the manufacturing process

Typically, raw material arrives, directly, from the main contractor (MC); thus the company does not have to manage the supply process, but it deals, exclusively, with the production process. Anyhow, when raw materials arrive, a first quality control is made to check compliances of the incoming materials with the packaging list. Authorised personnel analyses a sample of the batch (typically 20%) and counts the number of items received. After the check, material is stored in the warehouse. Next, when new productions orders are issued, a qualified operator use the MC's order document containing the Bills of Material (BOM), to check for materials' availability and, depending on that, productions orders are accepted or no. In case of non-acceptance - Not completed WIP - pending orders are shelved in appropriate boxes. Conversely, for all feasible orders, the production planner releases a document called Planning Orders, which includes the identification of the Must-be articles, which will receive production priority. Obviously, whenever new raw materials arrive, the state of pending order may change from Uncompleted WIP to Completed WIP and the corresponding production orders can be accepted and launched into production.

Generally the company processes batches of 50 to 80 SKUs (stock keeping units) depending on the time needed for preparation (i.e., change over) and to balance production flow. A batch can correspond to the entire order or to part of it, in case of very large orders.

Each batch is accompanied along its entire production process by two types of documents: the Production Order and the Processing Document, the latter one reporting data concerning the production phases.

Once a batch has been composed and positioned in a trolley, it is moved from the warehouse to the Preparation Department where six preliminary operations are done. Generally there are six operators at work, one for each operation, because none of them is multi-skilled. Next the batch is moved to the Control Area, where a quality check is made before qualified operators add the necessary accessories to the leather parts. This area has another function because it may act as a Stopping Area, where carts can wait before going to the assembly step performed

in the Production Department. This characteristic is very important as it allows to dynamically balancing the production capacity.
Finished products are manufactured in an assembly line, placed in the Production Department; next, trolleys containing the finish products move to Final Test Department where specialized operators make final touches operations, pre-tests and, eventually, block non-conforming products. After testing, good products proceed to the Package Area and can be shipped to the MC.

3.2 Development of the Scrumban Board

Step 1 - Understanding the Company and the Operators characteristics

During meeting with managers and shop floor workers, a detailed analysis of the production flow has been realized. The company organization, the products portfolio, the layout and the supply chain processes were studied and mapped. Finally the role of each worker was defined.

Step 2 - Defining the To-Do column

The *To-Do* column is shown in Figure 2. As it can be seen, an additional column, namely External Split and Skiving, has been considered, since the company sends to sub-contractors the leather to be skived and spitted. When the leather comes back, it is ready to be introduced into the production flow. This column is important because the leather is the main component of the end products and only after its arrival the Preparation can actually starts.

External Split and Skiving	Batching	To do (15) +3		
		Not Workable	Workable	Priority (10)
	Batch 1			
	Batch 2			
	Batch 3			
	Batch 4			
	Batch 5			
	Batch 6			
	Batch 7			
	Batch 8			
	Batch 9			
	Batch 10			
	Batch 11			
	Batch 12			

Figure 2. The To-Do column.

Next to the column just described, there is the *Batching* column, where the batches with Complete WIP (i.e., those order for which materials have already been collected) are inserted. Also note that the To-Do column has been divided into Not Workable, Workable and Priority. The operating functioning is as follows. Each Friday the production manager updates the To-Do column taking into account the Planning Document and the Panning Orders of the starting week. Kanban cards, corresponding to batches of the Must-Be articles are placed in the Priority column. Kanban must be ordered depending on their due date. Also, in order to keep the balance between internal and external production, it is necessary to consider the 1 to 2 proportion between internal and external batches (i.e., internal-internal-external sequences must be respected).
All the remaining orders of the Planning Order document must be inserted, as kanban, in the Workable column, and they must be ordered in terms of due date. Lastly, batches with Not Complete WIP must be inserted in the Not Workable column; however, since it is rare that the

Planning Order for the current week contains articles of Not Complete WIP type, this column is used, mainly, for unforeseen events.
Both the To-Do and the Priority columns have limits. The number (15) + 3 is the limit for the batches of the To-Do column; a threshold limit that corresponds to the weekly capacity of the company. More specifically, every week the Preparation department processes fifteen batches; next, after the Decoupling Point (see below), ten batches proceed internally, till the end of production flow, while the other five are shipped to external sub-contractors. Three more batches called Share of Flexibility have been added because, sometimes, the number of weekly batches may be higher. These three batches correspond to the extra capacity that can be achieved with nine hours of overtime (1 hour daily from Monday to Friday and 4 hours on Saturday) and considering that, to complete a batch in the Preparation Department, 2.45 hours are needed, on average.
The number 10 is the limit for the Priority column; theoretically it should equal the limit of the "To Do" column (i.e., it should be 15), but this does not apply well for manufacturing firms. As described before, workers do not follow the same batch from start to end and, thus, the maximum limit does not equal the number of workers. In manufacturing companies, a minor misalignment with the theory of Scrumban instrument is needed: in our case a limit of 10 batches corresponds to an operating limit imposed by the preparation department. Those 10 batches must be ready for Preparation so the warehouseman must keep under control the preparation of the trucks especially the 10 priority batches. When the first batch of Priority goes into Preparation, a responsible moves the first tag of "Workable" to Priority in the last position.

Step 3: Understanding Supply Chain

Final-adjustments, Test and Packaging are generally performed in house at the Production department. However, the company can outsource these activities from a group of external contractors, to whom production batches are shipped after the internal preparation has been completed. The important point is that, the Preparation department processes more batches than the Production Department, because it is responsible for processing batches for the external contractors, too. Thus, for balancing reason, we added the Preparation" and the Point of Control and Adding of Accessories columns before the WIP one, as clearly shown by Figure 4.
When the operators move kanbans from the Priority column, kanbans must be placed in the Preparation Column, following the same ordering rules, i.e., the kanban at the top corresponds to the batch with the closer due date and so on. A kanban remains in the Preparation column until the batch has been processed in the Preparation Department. After that, the kanban is moved to the Point of Control and Adding accessories column, where it waits until the corresponding batch is checked and all the accessories are added. This phase acts also as a Decoupling Point, because it is here that the company divides batches into internal and external one.
Also note how the Preparation column is characterized both by a minimum and maximum limit. A minimum limit of ten batches s needed to assure a continuous flow in the Production Department (i.e., a minimum of ten batches should be processed every week in the in "Preparation" department) and, in this case, ten kanbans must be in the Production column. The maximum limit of (15) + 3 batches means that at the same time, in Preparation there cannot be more than fifteen batches plus other three just in case of overproduction. If not so there is a bottleneck and the Production Department is blocked.
The limit of Point of Control and Adding of Accessories is the same as the column before it. If in the Control Area there are more than 15 batches plus 3 batches in case of overproduction at the same time, it means that there is a bottleneck.

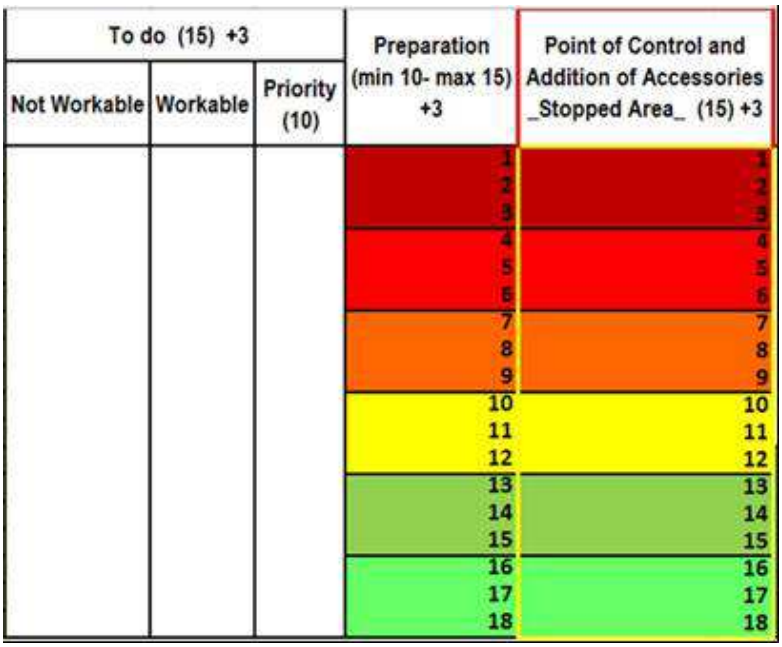

Figure 3. Preparation and Point of Control and Adding of Accessories columns.

Step 4 - The size of the Batch

As noted above, the company processes batches of about 50 to 80 SKUs.

Step 5 - Defining the Batch size and designing the Work In Progress column

The Production Department is composed of an assembly line with three workstations. Each workstation has two workers and a Cycle Time (CT) of 4 hours. Thus, as shown in Table 1, the total throughput time equals 1.5 days and the throughput rate equals 0.65 batches per working day.

	Monday morning	**Monday afternoon**	**Tuesday morning**	…
Workstation 1	Busy Processing Batch#1	Busy Processing batch #2	Busy Processing Batch #3	…
Workstation 2	…	Busy Processing Batch#1	Busy Processing batch #2	…
WorkStation 3	…		Busy Processing Batch#1	…

Table 1. Work Load on Workstations.

The same structure is represented in the Work In Progress column of the Scrumban table of Figure 4. More precisely, there are five sub-columns: three for the above mentioned assembly stations and two for the Pre-Test and for the Test step, respectively.

Also, since assembly can be performed externally, as subcontract work, the board has been horizontally divided in two sections, to properly visualize both the internal (in white) and the external (in light blue) path followed by the batches.

Kanbans for internal productions are placed in the white part of the boards, according to their daily schedule, detailed, for each assembly workstation, from Monday morning to Friday afternoon. Note that there is space to schedule ten consecutive batches, at most. However an additional kanban can be inserted in the light green row at the bottom of the board. This kanban signal the need to use overtime and/or to accelerate the line (for instance with extra workers) to catch up time or to respond to peak of demand.

Conversely, kanbans related to subcontract work are placed in the specific cells in the light blue area. When batches are shipped back, kanbans are placed in the following WIP sub-columns and follow the rest of the standard internal process (i.e., Final Adjustments, Test and Packaging). Note that, in the example of Figure 4, we considered three subcontractors (i.e., S1, S2 and S3) that, together, can absorb an average production of five batches.
Production's quotas are in proportion 1:2:2 so, as shown by the number in brackets and by the number of free cells in the light blue area of the board, one kanban card can be assigned to S1 and two can be assigned to S2 and to S3. In addition there are also cells with a *green cross symbol* signalling that, in case of overproduction, each subcontractor can accept up to two extra batches.

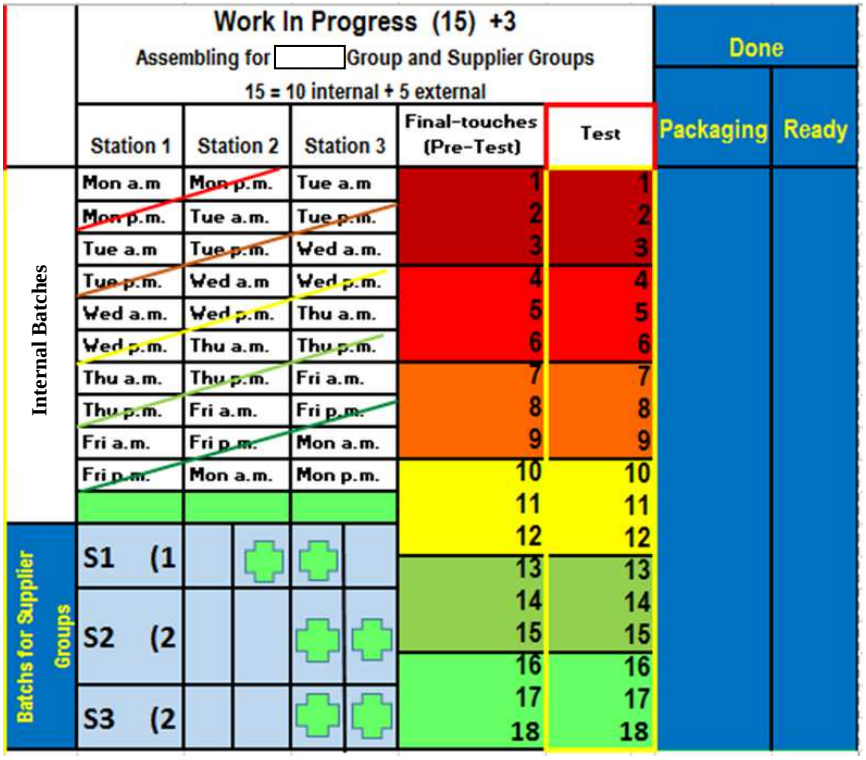

Figure 4. "Work in Progress" and "Done" column.

Step 6 - Limit the Work In Progress
As for the Preparation Column, the limit of the Work In Progress column equals eighteen batches, which corresponds to the sum of ten batches processed by the Production Department, five batches processed by subcontractors and three extra batches, defined as Share of Flexibility. Consequently, no more than fifteen kanban should be placed simultaneously on the board. If this number is trespassed (i.e., there are sixteen to eighteen cards) the board immediately signals the station that is acting as a bottleneck and the need for overtime. Anyhow, more than eighteen kanbans cannot be placed on the board for any reason; the process does not have enough capacity to handle this extra workload and the effect would be that to generate confusion, queues and additional delays. So, orders must be kept in a pre-shop pool until some free capacity becomes available. Meanwhile the Main Contractor must be warned of possible delays and, eventually, a new due date must be defined.

Step 7 - Defining the Done column
As shown in Figure 4. the Done column does not have any limit and it is divided into two sub-columns. These are the Packaging and Ready columns that contain, respectively, kanbans of batches that are being packed or that are ready to be shipped. After a batch has been shipped the relative kanban card can be removed from the scrumban table.

Step 8 - Defining the Scrumban Card

To define the graphical layout of the kanban cards, we identified all data retained critical for tracking purposes. Before the introduction of lean thinking, the company already used a document, namely the Production Document, which followed each batch along the production process. Thus we used this document as the starting point for the definition of the kanban cards. The obtained layout is shown in Figure 5.

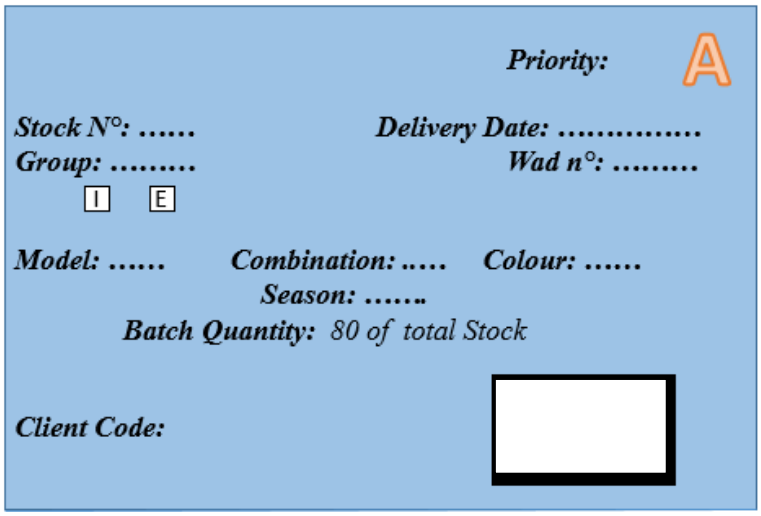

Figure 5. The Scrumban Card.

- *Priority* is used to rank batches in the scrumban board. A, B and C denote high, medium and Low priority, respectively. Batches sharing the same priority level will be scheduled according to their delivery date.
- *Stock N°* refers to the MC Order document. As above mentioned, together with production orders, the company received all the necessary stocks of raw materials from the MC. Since orders can be processed in smaller batches of 50-80 SKUs each, the kanban card must indicate the original Stock of the batch.
- *Batch Quantity* specifies the exact number of SKUs contained in the batch.
- *Group* indicates if the batch will be processed in house (the I check box is marked) or outside (the E check box is marked). If the batch is processed outside, the extended name of subcontractor must be written, too.
- *Client Code* is the Alfa-numerical code that identified the customer.

All the other fields contain descriptive data regarding the products being processed. Also the colour of the card is used to differentiate the different types of products. All colours, except red, can be used. Red is associated, exclusively, to not-conformed products: when batches are controlled, non-conformed parts are grouped to form a new batch (needing reworking) to which a red kanban is assigned. This kanban has the same structure of the standard ones and can be placed, with high priority, in the scrumban board.

3.3 Operating functioning and concluding remarks

Scrumban is a Visual Management tool and, as such, it should be easy to read and it should convey most of the information in a visual way. Specifically, watching the board, one should be immediately able to understand if and where something is going wrong. For this purpose, see Figure 3 and Figure 5, all the columns corresponding to a step of the manufacturing process have been divided into rows/blocks with different colours (from red to green). Specifically, due to a weekly WIP limit of fifteen batches, a correct functioning corresponds

to three batches produced per day. Consequently, in each column there five blocks of three batches each (for example the first one in dark red corresponds to the batches that should be finished on Monday) plus one block (in light green for extra batched). When batches are physically moved from one production area to the next one, the corresponding Kanban cards are moved horizontally along the scrumban board, and the free cells are kept empty until the following week when a new schedule will be made. In this way it is easy to see if the process is under control. Indeed, to have a perfect production flow there should not be more than three batches simultaneously in each one of the above mentioned.
Concerning workstations S1, S2 and S3, the correct production flow is visualized in a slightly different way. In this case, since each workstation has a cycle time of four hours, there are ten blocks each one corresponding to a time slot of four hours. If everything is going well there should be three kanban cards for each time slot, one for each workstation. Also, due to a correct time phasing, kanbans should be arranged along one of the diagonal lines drawn in the board. For example, if we consider the fourth time slot (i.e., Tuesday afternoon), S1 S2 and S3 should be processing Batch #4, #3 and #2, respectively (as indicated by the brown inclined line).

4. Conclusion

The work discussed the potentialities of Scrumban in manufacturing firms. Scrumban is a visual tool typically used to synchronise activities of complex software development projects. a particular lean technique called Scrumban with a focus on manufacturing industries. The use of Scrumban is straightforward in the software industry, but not in manufacturing, where the tool must be rethought and properly customized.
In this work, a case study, concerning a small fashion company, has been used to assess the potentialities of Scrumban in the manufacturing; from the experience gained on the field a simple and flexible procedure to properly implement the tool has also been developed. Specifically, the proposed methodology allows achieving three main objectives:

- To constantly track the state of the WIP and the manufacturing performance of the production line;
- To identify possible bottlenecks and/or inefficiencies and, consequently, to eliminate them within a continuous improvement perspective;
- To motivate and empower people and to continuously evaluate the quality of their job.

In fact, as any lean techniques, Scrumban aims to eliminate wastes, reducing costs and production times and improving quality with a continuous improvement mind-set; but in addition to the others, it has the characteristic of being strongly focused on people. Therefore, for the tool to be used there is the need of identifying duties and responsibilities of the employees involved in the production process.
At present the analysis has been limited only to Make-To-Order manufacturers operating in the luxury fashion sector. However, obtained outcomes indicate the possibilities to apply it in different sectors, other than the Fashion Luxury one. To empirically validate this hypothesis, additional practical tests should be made in other Make or even Project To Order sectors such as the Aerospace, the Naval and the Industrial Plants. These may be topics for future researches.

5. References

Carmignani G., Zammori F., 2015. Lean thinking in the luxury-fashion market. Evidences from an extensive industrial project. *International Journal of Retail & Distribution Management*, Vol. 43 No. 10/11, pp. 988-1012.

Dangayach, G.S., Deshmukh, S.G., 2003. Evidence of manufacturing strategies in Indian industry: a survey. *International Journal of Production Economics*, Vol. 83, pp. 279-298.

Febles Acosta, J., Oreja Rodriguez, J.R., 2008. Factores Externos e Internos Determinantes de la Orientaciòn de la Cultura Estratègica de las Empresas, *Investigaciones Europeas de Dirección y Economía de la Empresa*, Vol. 14, pp. 13-32.

Ladas, C., 2008. Scrumban. *Lean Software Engineering-Essays on the Continuous Delivery of High Quality Information Systems*.

Ladas, C., 2008. Scrumban: Essays on Kanban Systems for Lean Software Development. *Modus Cooperandi Press*, Seattle, WA, USA.

Laosirihongthong, T., Dangayach, G.S., 2005. A Comparative Study of Implementation of Manufacturing Strategies in Thai and Indian Automotive Manufacturing Companies. *Journal of Manufacturing Systems*, Vol. 24, pp. 131-143.

Li, H.H.J., Tan, K.H., 2004. SMEs business growth model: a medium to big effort. *International Journal of Management and Enterprise Development*, Vol.1, pp. 195-207.

Maylor, H., 2001. Beyond the Gantt chart: Project Management Moving on *European Management Journal*, Vol. 19, pp. 92-100.

McKay, K.N., Black, G.W., 2007. The evolution of a production planning system: A 10-year case study *Computers Industry*, Vol. 58, pp. 756-771.

Nikitina, N., Kajko-Mattsson, M., Stråle, M., (2012). From Scrum to Scrumban: A Case Study of a Process Transition. *Proceedings of the International Conference on Software and System Process*.

Poppendieck, M., Poppendieck , T., 2003. Lean Software Development: An Agile Toolkit.

Raymond, L., Croteau, A.M., 2006. Enabling the strategic development of SMEs through advanced manufacturing systems: a configurational perspective. *Industrial Management & Data Systems*, Vol.106, pp. 1012-1032.

Sienkiewicz, Ł., 2012. Scrumban the Kanban as an addition to Scrum software development method in a Network Organization. *Business Informatics*, Vol. 2, pp. 73.

Suna, T.L., Kuob, W.L., 2002. Visual exploration of production data using small multiples design with non-uniform colour mapping. *Computer and Industrial Engineering*, Vol. 43, pp. 751 – 764.

Voss, C.A., 1995. Alternative paradigms for manufacturing strategy. *International Journal of Operations & Production Management*, Vol. 15, pp.5 – 16.

Wang, X., Conboy, K., Cawley, O., (2012). Lean agile software development: An experience report analysis of the application of lean approaches in agile software development, *The Journal of Systems and Software*, Vol. 85, pp.1287-1299.