ANALYSIS OF INDUSTRIAL PROCESSES BASED ON INTEGRATION OF DIFFERENT SIMULATION TOOLS

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Abstract:

The present paper provides an example of software tools integration in order to perform simulations in complex industry models, such as a ceramic tile manufacture. The first part of the paper presents the features of the two simulation tools adopted: AutoMod™ and VirtES. AutoMod™ is a commercial suite of simulation tools witch provides an environment easy to develop highly accurate models for analysis. VirtES simulation tool was developed by the Industrial Plants Research Group of the Department of Industrial and Civil Engineering (DIMeC) of the University of Modena and Reggion Emilia. Models developed in VirtES are useful to investigate macro Key Performances Indicators (KPI), such as economic indicators. The integrated used of VirtES and AutoMod™ allows to perform accurate simulation at line production level developed by AutoMod™ in multiple virtual scenarios created by VirtES.

Keywords:

Tile, ceramic, simulation, process, AutoMod.

1. INTRODUCTION

The tile industries in Europe are concentrated in Italy, in the “Emilian” region, and in the Spanish cluster of “Castellon” [4]. These industries are dedicated to the production of tiles for the building sector to isolate floors and walls. An exhaustive description of the production system in the tile industries was given by Andrés in 2005 [1]. Tile industries were originally characterized by large scale production of a limited range of products. Over the last few decades consumer demand for tiles has changed, becoming more sophisticated. Currently tile industries produce a considerable variety of products with shorter life cycles [1]-[2]-[4]-[6]. These characteristics are much more significant for the Italian (Emilian) cluster of companies because they are focused on higher end more sophisticated markets and give more attention to product differentiation [4]. The continuous increase of the number of products creates scheduling problems such as lead time and batch reduction sizes, that are not compatible with tiles production system [3]. The ceramic tile industries are involved in a radical redesign of production and management processes due to the changes occurring in the markets. Ceramic industries have historically a mass – production approach to markets and the use of simulation tools is not wide spread. In the last years ceramic industries are pushed towards a more flexible and adaptive production system. The difficult focusing how to make the production system more flexible and adaptive is point out by an empirical study by Bonavia. This study verified that most Lean Production (LP) practices are still not adopted in ceramic industries [2]. Ceramic industries production and management processes should be improved but there is not enough budget devoted to redesign

processes, due to industries size. In fact ceramic industries are mostly small – medium enterprise (SME) focused on short term results such as productivity and efficiency.

2. SIMULATION TOOLS FOR CERAMIC INDUSTRIES

Ceramic industries need tools that allow to attempt the redesign of production and management processes. A double stage simulation approach is supposed to be useful. An higher level simulation tool is needed in order to investigate the critical processes and to support processes redesign. A lower, more detailed tool is needed to quantify the impact of the proposed changes at line production level.

An example of this double stage approach is given in this work. The lack of a specific simulation tool for ceramic industries forces the development of VirtES. The possibility to develop a model in a process – oriented environment drive towards AutoMod™ as the lower simulation tool. The integration of AutoMod™ with VirtES allow to perform simulation in multiple virtual scenarios giving results in term of use of productive capacity of production lines.

2.1. VIRTES

VirtES simulation tool was developed by the Industrial Plants Research Group of the Department of Industrial and Civil Engineering (DIMeC) of the University of Modena and Reggion Emilia. VirtES performs stochastic simulation based on factory data model (FDM). The FDM model allows to create an enterprise model starting from described industrial processes [8]. In order to create a virtual enterprise it is necessary to realize an input – output chart for each process in the model and to provide a complete processes interaction chart. Processes described are codified to allow implementation into a Scilab environment in order to be performed by VirtES. The FDM model was adopted to model a generic manufacturing tile [3]. The model performed by VirtES is mainly used to investigate the influence of management decision related to a BPR (Business Process Reengineering) scenario. VirtES allowed to include new processes in the model very easily. This feature promotes the enlargement of the investigation field to those aspects, that generally are neglected.

2.2. AUTOMOD™

AutoMod™ is a commercial process – oriented simulation tool. AutoMod™ suite includes templates to accurately model material handling systems, including conveyor, lift truck, operator, automated vehicle, overhead crane, power and free, ASRS (Automated Storage/Retrieval System), and any cinematic device. AutoMod™ uses CAD-like features to define physical manufacturing layout, material handling, processing, and distributed systems. AutoMod™ powerful graphical interface accurately captures physical constraints of distance, size and space in three dimensions. The AutoMod™ potential is quite similar to the other commercial simulation tool object – oriented as eM-Plant™ [5]-[7]. The characterizing feature of AutoMod™ is the possibility to develop the model in a process – oriented environment. Almost all the commercial simulation suites could be properly used to perform simulation in a well established scenario and gives detailed information about the analyzed processes and objects.

3. INFORMATION QUALITY IMPORTANCE FOR CERAMIC INDUSTRIES

VirtES generic tile manufacture model was developed and used to point out the importance of two key – factors for tile industries performances: the reliability of outstanding orders and the presence of sub groups based on colour variation (tone) in finished products [3]. Both factors are specific of ceramic industries. The partial unreliability of outstanding orders is related to the unstructured selling activities. The presence of sub groups in produced tiles is a specific feature of the ceramic production process itself.

This work presents the double stage simulation approach applied to a specific case study. In this work the double simulation approach is used to quantify the influence of unreliable orders on production capacity utilization at line production level. The generic tile manufacture model in VirtES is set with the macro – parameters of the case studied. Then a specific line production model is developed in AutoMod™ and this model performs simulations with the input data given by VirtES.

3.1. Impact of information quality on KPI using VirtES

The generic tile manufacture model performed by VirtES monitors these key performance indicators (KPI):

- the total amount of tiles sold,
- the average amount of warehoused tiles,
- the orders waiting for production.

The simulations are performed for 350 days (1 year) and the main parameter are set as presented in table 1, according to case study values.

FIRM FEATURE	SETTING
Nominal productive capacity	2.500 m^2/day
Orders distribution	Costant from 10 to 500 m^2
Products	50 items
Schedule time	20 days
Warehouse service level (imposed)	60 days
Minimum batch size	500 m^2

Table 1: parameters set in VirtES model

Two different scenarios were considered, the first one provides simulation with a completely reliability of outstanding orders (called TA00). The second scenario provides simulation with a partial unreliability of the outstanding orders (called TA20). In the second scenario one order out of five is unreliable. The unreliable orders (called “fake orders”) act in the model for a certain number of days and then they are cancelled. During their life period fake orders affect the production scheduling plan. The VirtES results for the two scenarios are shown in table 2 and in fig. 1 and 2. The error on simulation results, due to the stochastic nature of VirtES model, is less than 3% for each KPI. In each simulation a production plan is realised. Scheduled items sequence, which is the output of VirtES, is used as input for AutoMod™.

	Sold tiles m^2	Warehoused tiles m^2	Waiting Orders m^2
Scenario TA00 (outstanding orders reliability)	635.978 ±3%	340.427 ±3%	0 ±3%
Scenario TA20 (outstanding orders unreliability)	517.730 ±3%	345.382 ±3%	126.863 ±3%

Table 2: KPI values at the 350th day of simulation (VirtES)

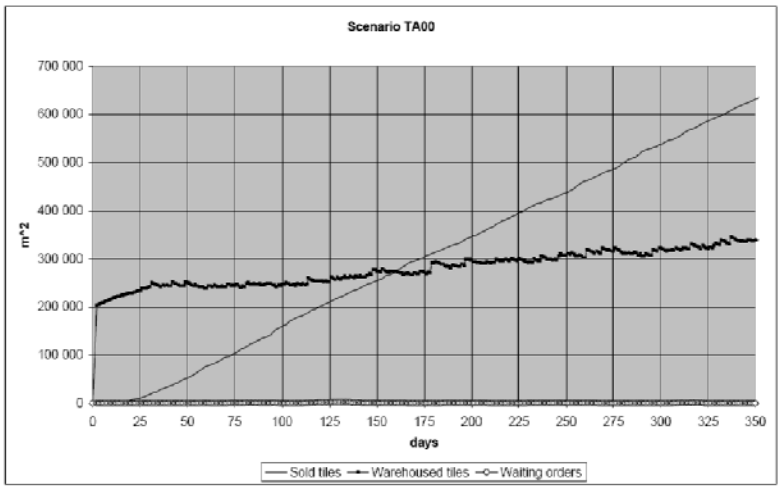

Figure 1: output Scenario TA00 (VirtES)

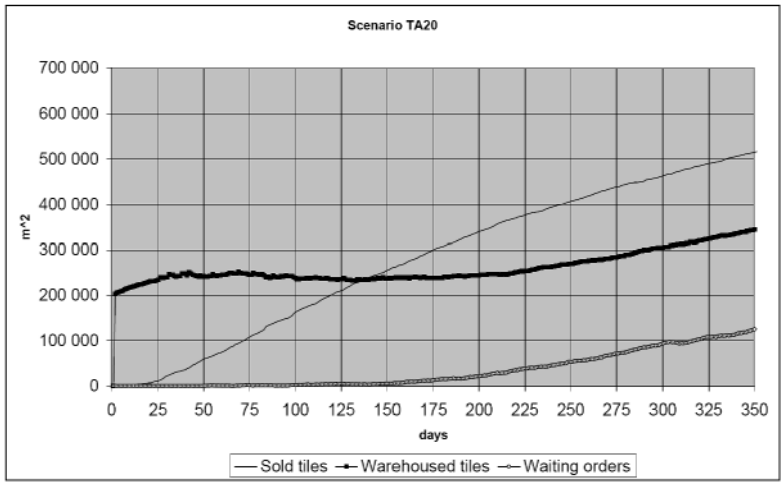

Figure 2: output Scenario TA20 (VirtES)

3.2. Impact of information quality on production line using AutoMod™

The impact of information quality on productive capacity utilization is investigated using a second level simulation tool. The simulation performed with VirtES provides two different production plan for the two different scenarios (TA00 and TA20). Two simulations with AutoMod™ model are performed for periods of 30 days, starting from the 100th day of VirtES simulation in order to avoid the initial warm-up. The length of the simulation run was set to guarantee the relevance of the results. The results are compared in term of production capacity utilization and of total production. The results are pointed out in table 3 and 4.

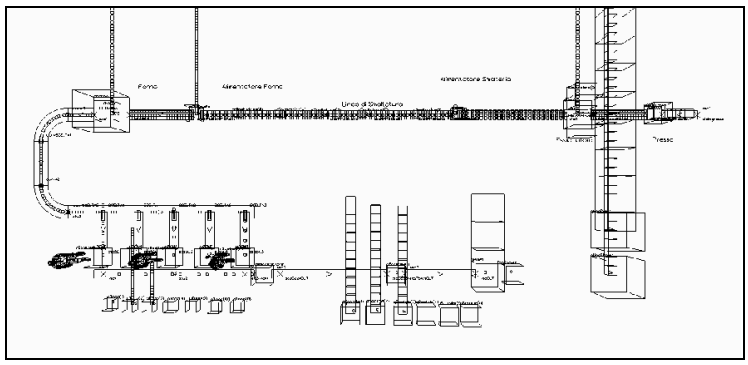

Figure 3: the model in AutoMod™

	% Press utilization	% Drier utilization	% Kiln utilization	% Sort1 utilization	% Sort 2 utilization	% Sort 3 utilization
Scenario TA00	31,5	63,5	78,4	76,8	76,8	76,8
Scenario TA20	27,5	55,5	68,6	68,5	68,5	68,5

Table 3: resources utilization during a 30 days period (AutoMod™)

	Total produced tiles m^2	Number of complete pallets N°	Tile in complete pallet m^2	Number of free boxes N°	Tile in incomplete pallet m^2
Scenario TA00	73.147	1.110	71.928	1.016	1.219
Scenario TA20	70.601	1.062	68.818	1.486	1.783

Table 4: produced tiles in a 30 days period (AutoMod™)

4. CONCLUSIONS

Models implemented in VirtES are useful for the investigation of production and management processes in a tile manufacture. Simulations performed with VirtES give information in term of macro KPI such as: the total amount of sold tiles, the average amount of stocked tiles and the orders waiting for production. This kind of information is relevant in a long term scenario of BPR. It is a valid support for management in defining the future investment plans and in preparing a reorganization process. Nevertheless VirtES model are not so accurate to produce results at production line level; for this kind of analysis a commercial simulation suite is preferred, such as AutoMod™. The results provided by AutoMod™ simulations point out the effects of changes and allow management to avoid possible undesired effects. AutoMod™ results underline how an improvement in the reliability of the outstanding orders has not negligible impact on production line performances. There is a generalized improvement in the machineries utilization. The utilization rate of kiln facility grow up to about 10 points. This is a remarkable result considering that kiln is the most expensive facility for the initial investment and the operating costs. The total amount of tiles produced, due to grater batch size scheduled on production line, increases up to 5%. It could be argued that using AutoMod™ alone, or any other commercial suite as eM-Plant™ or Arena™, prevent to investigate the influence of external factor such as the outstanding orders reliability. In fact the development of such a model, including organizational and commercial aspects, is too much complicated and needs too much financial resources and time for SME. The double simulation approach consists in a upper level simulation tool dedicated to a specific industrial field (the ceramic tiles one, in this case) and in a commercial suite to report common results to the specific case studied. This method combines the extreme flexibility of a general purpose tool, developed for a specific industrial field, to the accuracy of a commercial suite.

5. REFERENCES

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