ULBS
Universitatea "Lucian Blaga" din Sibiu

Eng. MariaVirginia IUGA

DOCTORAL THESIS SUMMARY

Contributions to the design of a lean communicational model at shop floor level, applicable within the automotive industry

Thesis evaluation commission / Comisia de evaluare a tezei de doctorat:

President / Preşedinte:
Prof.univ.dr.ing. Liviu-Ion ROȘCA, Universitatea "Lucian Blaga" din Sibiu

Members / Membrii:

Prof. univ. dr. ing. Claudiu Vasile KIFOR	**Scientific Coordinator / Conducător științific** Universitatea "Lucian Blaga" din Sibiu
Prof.univ.dr.ing. Anca DRĂGHICI	Universitatea Politehnica Timișoara
Prof.univ.dr.ing. Sorin Gabriel POPESCU	Universitatea Tehnică din Cluj-Napoca
Prof. univ.dr. ing. Ioan BONDREA	Universitatea "Lucian Blaga" din Sibiu

2015

Table of contents

List of terms and abbreviations

No.	Abb.	Explanation
1	Andon	Visual control device indicated status of a machine
2	Cg	Capability gauge
3	Cgk	Capability gauge index
4	Chaku-Chaku	Equipment ejecting the finished piece for the **operator** so that the operator can move from machine to machine within a cell.
5	Cm	Capability machine
6	Cmk	Capability machine index
7	CNIPMMR	National Council of Small and Medium Private Enterprises in Romania
8	COR	Codification of Rumanian professions
9	Cp	Capability process
10	Cpk	Capability process index
11	CW	Calendar Week
12	CZDIS	Visualization method: Central/ zonal: displays for general information (statistics, events, days off, etc.) with data derived from a central computer
13	CZELPA	Visualization method: Central/ zonal: electronic panel for a production area showing the operating status of all machines in the area
14	CZINPA	Visualisation method Central/ zonal: statistical data listed on paper and updated at least once a month
15	EFQM	European Foundation for Quality Management
16	FAM	Familiarity: criterion to select KPIs
17	FMEA	Failure mode and effects analysis
18	EOU	Easy of use, management facility: criterion to select KPIs
19	FTE	Full Time Equivalent
20	FTY	First Time Yield
21	Gemba	Shop floor
22	Genchi Genbutsu	Going on site
23	GM	General Motors company
24	Go&See	Going on site
25	Heijunka	Leveling the load of the station or production line
26	HRM	Human Resources Management
27	HRS	Human Resources Strategy
28	IHS	Investments in Hardware and Software
29	IM	Information Management
30	ISO	International Standardization Institute
31	ISO TS	International Standardization Institute, Technical Specification
32	IT	Information Technology
33	ITR	Investments in Training: criterion to select KPIs
34	Jidoka	Stopping automatically a production line when a defect is detected
35	JIT	Just in Time
36	JLMS	Joint Labor Management Committees
37	Kaizen	Term used to define the continuous improvement (Jap.)
38	Kanban	Control process through cards, signs, which trigger movement in the downstream process flow of products between workstations.
39	KM	Knowledge Management
40	KPI	Key performance indicator
41	Leader	For this thesis the leaders are considerated all persons in organization who have administrative leading other persons(e.g. shft leaders
42	LM	Lean manufacturing
43	M	Mean (statistics)
44	MBWA	Management by Wandering Around
45	MCDM	Multi Criteria Decision Making
46	MEP	Marquardt Efficiency Process
47	MPS	Mercedes-Benz-Produktionssystems
48	MRO	Maintenance, Repair and Operating supplies
49	MRP	Material Requirements Planning (computerized)
50	MSR	Marquardt Schaltsysteme Romania
51	Muda	Waste
52	N; No	Number

No.	Abb.	Explanation
54	OEE	Overall equipment effectiveness
55	OEM	Original Equipment Manufacturer
56	One piece flow	Principle that products move continuously through the processing steps
57	PCB	Printed circuit board
58	PDCA	Plan-Do-Check-Act (Deming circle)
59	PFP	Paid for performance
60	PM	Project Management
61	Poka Yoke	Device for preventing errors (Mistake Proofing)
62	PPLBILB	Visualization method: Per production line: board at the end of the line (machinery) based on interactive updates of the shop floor employees
63	PPLELS	Visualization method: Per production line: electronic screen at every line (machinery) based on electronic data updates of production data (produced quantities, defects, etc.) and real time visualization
64	PPLSTA	Visualization method: Per production line: stoplight indicator, operated automatically, indicating the operating status of the production line
65	PPLSTM	Visualization method: Per production line: stoplight indicator, operated manually, indicating the operating status of the production line
66	ppm	Parts per million (defect rate)
67	PSP	Profit-Sharing Plans
68	Pull Production	System in which an upstream workstation produce only by signal from downstream station
69	QPN	Qualification Program of New products
70	R&D	Research and Development
71	RASCI	Communication plan R: responsible; A: accountable; S: support; ....C: consulted I: informed
72	RG	Maturity Degree (VW required KPI for new products=Reifegrad)
73	ROA	Return On Assets
74	ROE	Return On Equity
75	ROI	Return On Investment
76	RPN	Risk Priority Number (Failure Modes and Effects Analysis)
77	SD	Standard Deviation
78	SFC	Shop-Floor Committees
79	SFM	Shop-Floor Management
80	SMED	Single-Minute Exchange of Dies, equipment changes from one physical state to another.
81	T, t	Time, Set-Up Time
82	TBF	Time Between Failures
83	TPM	Total Productive Maintenance
84	TPS	Toyota Production System
85	TQM	Total Quality Management
86	TS	see ISO TS
87	UK	United Kingdom
88	UPM	Utility for Process Management: criterion to select KPIs
89	USA	United States of America
90	UT	Update Time: criterion to select KPIs
91	VMPS	Virginia Mason Production System
92	vs.	versus
93	VSM	Value Stream Mapping
94	WIP	Work In Progress
95	ZPAHO	Visualization method: Zonal: Paper holders (flip charts) with interactive data updated by employees
96	ZWHBO	Visualization method: Zonal: White board with interactive data updated daily by employees
97	3W	Three fundamental questions: Who? What? Why?

List of Tables

List of Figures

Keywords

Communication, Lean Manufacturing, Shop Floor, Communication Standard, Visual Management, Time Management, KPIs

Acknowledgements

This paper is the result of many years of practical work experience, intensive study and research. This thesis is the result of work not only invested by me but also by other people who supported me directly or indirectly and have contributed to my professional and academic development, who I wish to thank.

First and foremost, my gratitude and thanks go to Prof. univ. dr. ing. Claudiu Vasile Kifor, my scientific coordinator, for the very thorough guidance, scientific advice and not least for the high and excellent standards he imposed to this work. I want to thank him for his trust, patience and professionalism which guided me along this scientific research.

Also sincere thanks go to the mentoring committee; who guided me through these years, respectively prof. univ. Dr. ing. Ioan Bondrea, prof. univ. Dr. ing. Liviu Ion Roşca, prof.univ.Dr.ing. Lucian Lobonţ for the objective analyses of the scientific reports achieved during the doctoral studies, for their help and trust. For all the trust put in my work and insightful advices I also want to thank the members of the evaluation committee: prof. univ. Dr. ing. Anca Drăghici and prof. univ. Dr. ing. Sorin Popescu.

Special thanks go to the management and staff of Marquardt Schaltsysteme SCS Sibiu who gave me the much needed experimental frame for my research and the support in obtaining practical results. This research would have not been possible without their support and trust. Not least I wish to thank the management of the Faculty of Engineering from the "Lucian Blaga" University of Sibiu, teachers, especially dr.ing Mihai Zerbes for his collegial help and support, dr. ing Amelia Bucur, fellow PhD students and administrative staff of the Doctoral Studies Department for the help and support provided throughout the entire period of my research.

Last but not least, my gratitude goes to my family, my husband and my daughter, for the support and for the understanding offered in the last years.

.

I. Thesis overview

I.1. Motivation

In the actual globalization era the organizational competitiveness is in an uptrend due to the increasing requirements of product quality, industrial process optimization and increased investment in staff training and staff motivation. Nowadays managers face a critical problem – achieving profitability with high productivity, low production costs and quality of goods and/ or services (Kifor & Oprean, 2002). In fact, managers worldwide notice, or should notice, wastage at all levels. Within a brief comparison with the Toyota Production System (TPS) principles most points show potential for improvement. Currently, we are facing a situation where the organization is discretely threatened by a factor whose importance seems to really not be considered: the communicational-decisional structure at shop floor. It remains mostly anchored in old patterns, leading to adverse effects on sustainable processes implementations. Even if the "lean" concept was initiated within the automotive industry, nowadays it has been expanded within other industries or in services because applying these concepts is a necessity for the survival of organizations. The undertaking, from being optional, becomes mandatory in order to assure the company's stability on market

The scope of this research is to analyze the need of "lean" concepts that are directly applicable in automotive shop floor communication and to propose a model in order to eliminate communicational waste. In the following this paper, the production department, will be describe using the term "shop floor" or "Gemba".

I.2. Goals

The main objective of this study is to establish the improvement potential of the communication flow within the automotive industry at shop floor as well to create a generic model for lean manufacturing implementation in organization and to design a lean communication standard in Gemba starting from this model.

The secondary objectives of this study are as stated in Table 1

Table 1 Secondary research goals

Secondary goals
Research of the current status of LM implementation, models and methods
Analysis of the status quo of shop floor communication
Analysis of the risks and barriers which currently threaten LM sustainability
Proposal of an original, model to implement LM in an organization
Implementation of lean communication steps from the original model and validation of the results within an automotive company
Creation of an original 3W (why, what, who) model in order to in order to systematize shop floor KPIs
Proposal of an original, three-steps, selection of KPIs applicable at shop floor in order to determine the most effective KPIs
Creation of a process to apply multi-criteria analysis to select lean KPIs in organizations
Analysis of the status quo of time management, visual management and information management within the Romanian industry with focus on the automotive industry
Proposal of standards for visual management and time management

I.3. Research methods and techniques

The research had a structured approach starting with the information collection up to the validation of the proposed model, applying research techniques. The main two methods used were inductive and deductive methods. Induction required the integration of acquired practical skills in developing advanced models and implementing them. The deductive method was based on the formulation of hypotheses and their analysis, design and validation in real situations.

The techniques which were used in this research were as listed in

Table 2.

Table 2 **Techniques used in doctoral research**

Method	Scope
Literature research	In order to determine the current state of the art.
Quantitative research questionnaire	The technique was used twice in the research, first in order to establish the actual status of shop floor communication in automotive industry and the improvement needs and second to determine the improvements after implementation of model.
Brain storming	It was used in an organization in order to promote creativity and to get a pool of solutions for the three steps of communication management
Kaizen event/ workshop	Used during the entire project implementation. Scheduled kaizen events were planed and developed according to the implementation roadmap
Project management	Used during the implementation phase, each step was complex and therefore considered to be a project on itself
Mathematical modelling	Used in order to create a model of selection the appropriate KPIs which can be used in any domain
Original 3W method Why; What; Who	Used in order to select the utility was used to select of KPIs
Graphic interpretations of the results	illustrate the results of statistical analyses.
Quality tools&Toyota Production System instruments (5 why, Ishikawa, A3 problem Solving)	Used to determine the root causes of waste and to design the visual, information and time management
VOC (Voice of Customer)	Used to define the internal customer “needs” of lean shop floor communication
Project planning tools (Gantt chart/ Project schedule)	Used for planning the implementation of communicational management in the company

I.4. Thesis structure

This PhD thesis was structured in five stages, as underlined below:

The first stage, the state of the art, represents the current research state regarding LM, its transfer towards organizations, elements that build the fundament of LM, risks and influencing factors as well as LM communication. This stage is comprised of chapters 2 to 9.

The second stage, chapter 10, suggests an original approach regarding LM implementation

The third research stage, chapter 11, describes the analysis of the status quo of lean communication within automotive companies in Romania.

The fourth, chapter 12 describes the implementation of lean shop floor management within organizations starting with the data obtained in stages two and three and according to the model described in chapter 10.

Within the fifth and last stage, chapters 13 to 15, an analysis of the implementation results is performed and conclusions and future research needs are discussed.

Regarding the chapter overview, these were organized as followed below:

Chapter 2 presents general information about lean as concept including the actual state of the art regarding lean trends. Chapter 3 highlights the conclusions of previous research regarding LM implementation within organizations. Chapter 4 gives a state of the art overview of the LM communication. Chapter 5 analyses the influencing and risk factors associated with the implementation and maintenance of a lean culture within organizations. Chapter 6 analyzes the status quo of the element which precedes the LM implementation in organizations: management systems. Chapter 7 introduces the original concept of hard and soft tools and displays the hard tools, or in other words the Toyota methods and techniques. Chapter 8 presents the main aspects of the information and knowledge management and Chapter 9 show an original approach towards information expressed through KPIs at shop floor level and a proposal of successive KPIs selection and identification techniques of lean criteria, which served the purpose of identifying the optimal process of KPI selection at shop floor level. Chapter 10 proposes an original model of LM implementation: “Time to become lean”. Within the next chapter, 11 the results of the analyses of status quo of communication within automotive companies in Romania are displayed. Chapter 12 presents the implementation steps of the proposed model within an automotive company. The following chapter, 13, analyses the results of the implementation with the purpose to validate the model. Chapters 14 and 15 show the conclusions that were drawn and propose future research areas. Chapter 15 also presents the original contributions of this study to the research field.

II. Lean concept

II.1. Lean and the waste concept

The idea of lean in the current manufacturing environment is to work and produce from the perspective of the customer, and therefore to define value as a variable directly depending on the consumer of the good or service. Basically, lean is concerned with creating more value with fewer resources. In this context resources are defined as being: work; commercial consumptions; energetically consumptions; utility consumptions and sophisticated investments (Wang, 2010).

The essential difference between the classical view upon saving these resources and the Toyota philosophy is the right starting point “Low unit cost” in the traditional philosophy versus “Waste elimination” in the Toyota philosophy (Liker, 2004).

According to Jackson and Jones (1996), lean management refers to operating organizations the most efficient and effective possible, with the least cost and zero waste, a complete program that integrates long-term strategic development planning and day-today improvement targets in order to make companies customer-focused and flexible (Jackson & Jones, 1996).

In few words, lean manufacturing can be described as being a business philosophy that shortens the time between customer order and shipment by eliminating everything that leads to higher costs and longer periods of time (Bicheno, 2004).

Even though there are several types of lean methodologies regarding the lean process, they all incorporate and are elaborate on the tools and concepts founded and developed by the TPS (Davis, 2009). Based on the TPS philosophy, lean manufacturing is renowned for its focus on reducing the “seven wastes” in order to generally improve customer satisfaction. According to TPS, the term waste is used for any process that does not result in adding value to the final output or moving the process towards the final goal.

The TPS seven wastes defined by Ohno (1988) are as shown in Table 3

Table 3 The seven wastes

The seven waste types: TIMWOOD
Transportation
Inventory
Motion
Waiting
Over-production
Over-processing
Defective parts

To the seven types there is an eight waste discussed by the Toyota-philosophy: the unused employee creativity (Liker & Meier, 2006).

Reducing waste leads to not only improved customer service through a fast turnaround and a fast delivery but also to the achievement of several other objectives for organisation such as productivity improvement, manufacturing time saved, quality improvement, better labor utilization and so on. The main goal of the lean manufacturing system is therefore to eliminate the waste in all areas of the business, and more specifically to eliminate activities that the customer does not want to pay for.

III. Lean manufacturing implementation

Previous research regarding the implementation of LM within other organizations than the ones from the Far East, underlined two different challenges:

The first challenge consists in the transfer of know-how without the alteration of its accuracy.

The second one consists in the implementation itself which implies a right approach of the change management, of the acceptance of a new organizational culture.

III.1. Lean implementation models

According to Jackson & Jones (1996) the development framework for a lean manufacturing system into an organization implies three cornerstones of growth, nine keys of development and five levels of organizational learning. Figure 1 illustrates this model.

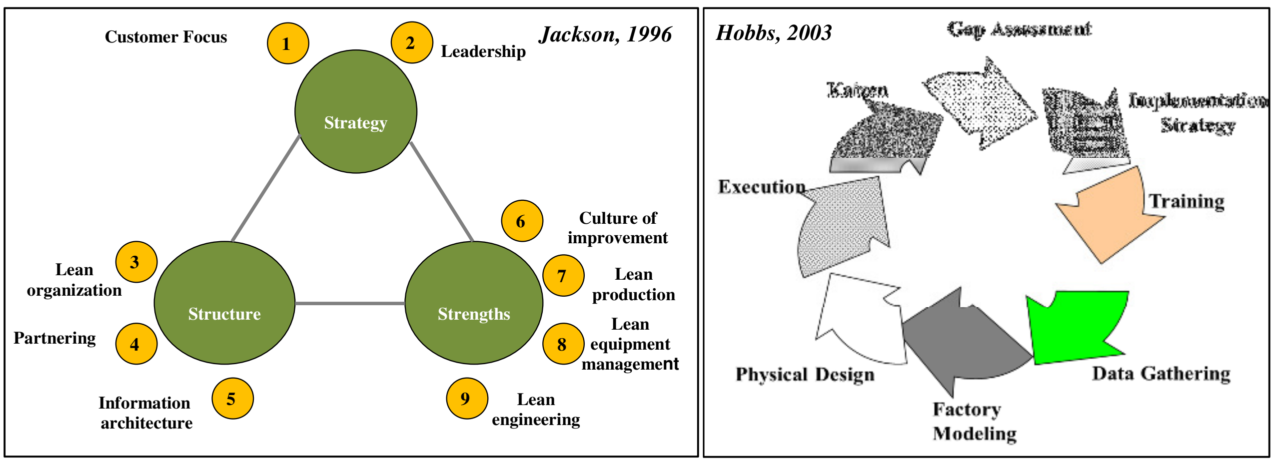


Figure 1 Jackson's (1996) and Hobbs (2003) models

On the other hand Hobbs (2003) proposes as model a methodical and disciplined approach for implementing lean manufacturing. The presented model, illustrated in Figure 1, is a cyclical one, similar to the one proposed by standard ISO 9000 for organization model.

Starting from the "Business Process Change Management" model, designed by Kettinger and Grover (1995), Motwani (2003) developed another LM implementation model. The model has been validated by the authors through case study conducted at a automotive supplier in the USA.

According to this model (Figure 2) the main requirements to achieve LM are: strategic initiative, learning capacity, culture readiness, relationship balancing, IT leveragability and knowledge capabilities and practices of process and change management.

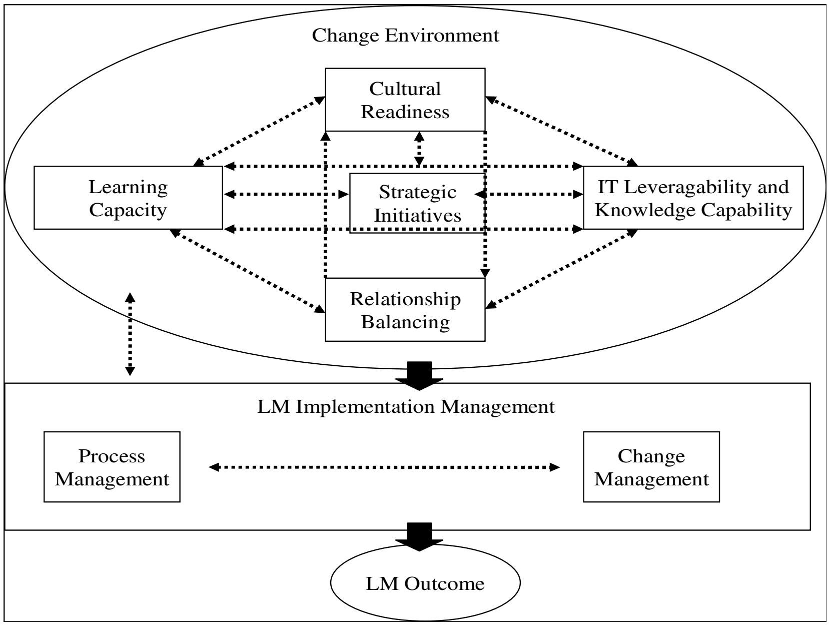


Figure 2: Motwani's development model (Adapted from Mootwani. 2003)

According to Toyota's principles, the implementation model of a lean manufacturing system should have two directions: process and people as shown in Figure 3. The implementation process should always start with small isolated projects and only then be developed and transferred within the whole organization (Liker & Meier, 2006). The final purpose is to create the learning organization which represents the first step to the lean enterprise. (Liker & Meier, 2006).

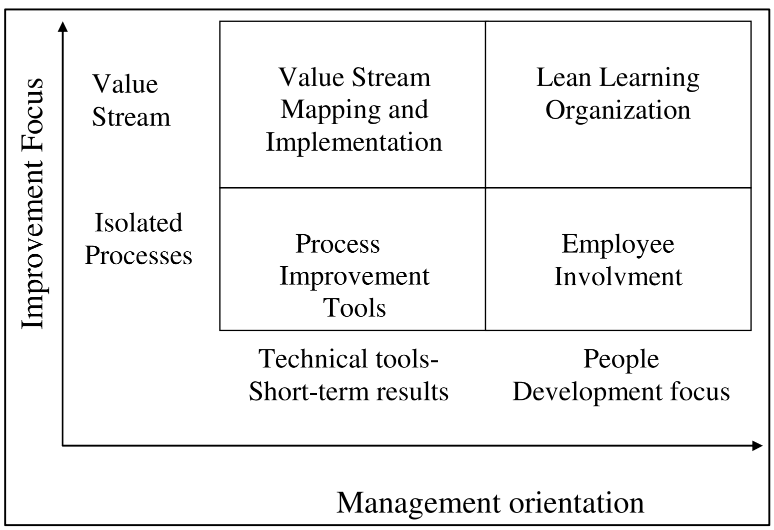


Figure 3 Toyota model according Liker & Meier (2006)

IV. Lean manufacturing, influences and risks

IV.1. Employees commitment

The role of employee commitment is one of the main success factors of lean implementation. Employee commitment was defined as the relative strength of an individual's identification with and an involvement in a particular organization (Mowday, Steers & Porter, 1982; Losonci, Demeter & Jenei, 2011). Before any radical changes occur, management should secure the commitment of employees through positive belief and trust in the change process. Losonci et al. (2011) built a model to analyze the factors determining perceptions of lean success, as shown in Figure 4.

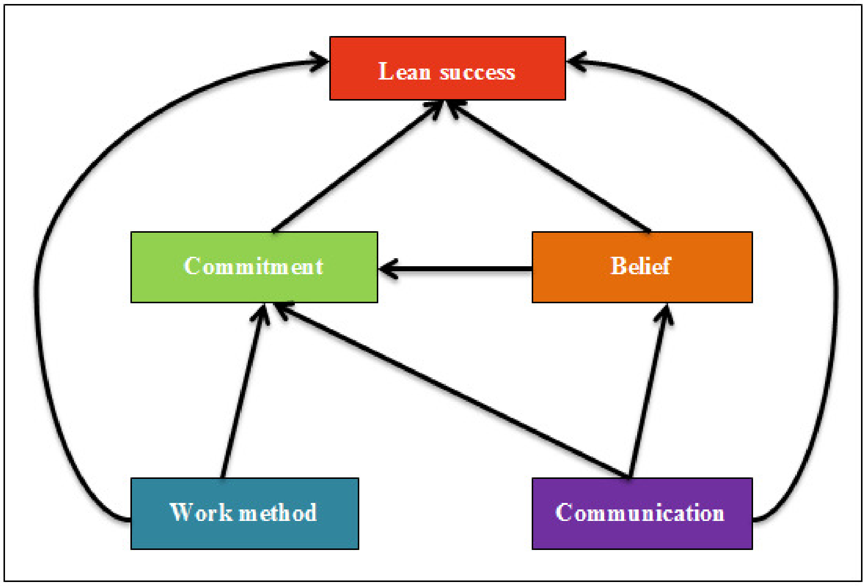


Figure 4 Predictors of lean success (Adapted from Losonci et al., 2011)

Belief, commitment, work method and communication all have a considerable direct effect on workers' perceptions regarding the lean success. Belief can have a significant effect on perceptions of success. It is critical during the initial phase of any transformation process to make sure that employees believe in the new initiatives. Enabling identification with company beliefs may enhance commitment among employees (Losonci et al., 2011). Communication is a key element of the organizational change process. Good communication leads to greater worker commitment. If the new work methods improve the people's own work (in terms of speed, quality, and ergonomics) and are used to effectively resolve everyday production problems, than they can have a positive effect on an employee`s feelings of success and additionally effect on the lean success.

V. Shop floor information management

V.1. General considerations

From an organization's perspective, the objective of information management is to provide valuable information that can be acquired and exploited to the fullest extent. The activities of information management can imply the creation, representation, organization, maintenance, visualization, sharing, communication and disposal of information. It is preferable that these elements are executed efficiently, meaning with minimum waste. From a lean conceptual level, these elements can involve adding value to information by how it is organized, visualized and represented and allowing information to flow to the end-user.

V.2. KPIs pool: literature survey

Using the Balanced Score Card (BSC) to drive organizational performance, Kaplan and Norton (2005) described metrics falling into two categories: results and drivers. Result metrics are generally outputs, as they report after the fact and are difficult to dissect to determine causes (e.g. financial metrics). Driver metrics have a direct impact on the performance of a business because they provide immediate feedback on how a process is running. They facilitate immediate improvement and provide a tool to allow managers to change immediately the behaviors that are causing the issues (Kaplan & Norton, 2005).

Michalska`s BSC also proposes a set of KPIs related to the organization`s strategy as "profitability ratio", "quality costs ratio", "efficiency ratio", "complaint amount" etc (Michalska, 2005).

In order to define organizational leanness Krichbaum proposes five categories of metrics: Safety; People; Quality; Responsiveness and Financial Performance (Krichbaum, 2007). More specifically, he proposes indicators as: "Days worked without a lost time accident", "Targeted Training Hours", "Delivered Quality", "Inventory Turns", "Rework / Repair Cost", " Customer Complaints", etc.

In order to establish the importance of various indicators from a large table of performance indicators available, (Bhatti, Awan & Razaq, 2014) questioned organizations in four areas: automotive, electronics, sports and textile. The conclusion was that for the entire manufacturing industry the most important indicator refers to product quality and particularly for automotive industry to customer satisfaction, which includes product quality The National Council of Small and Medium Private Enterprises in Romania (CNIPMMR), within the pilot project RO/03/B/F/FP-175017 regarding methods to reduce costs, suggests that lean indicators should be grouped in a BSC containing the following four elements: productivity, calculated as the ratio between output and input; quality, calculated as a percentage of good parts; safety and costs. For the last two elements they do not propose a specific indicator. Moreover they is suggested also the overall equipment effectiveness (OEE) (CNPIMMR, 2003).

MacDuffie and Pil (1995) mention a very similar categories of indicators as the previous authors and Gosselin classified the 73 most usual measures that he identified in 12 categories: Within this framework, he showed the need to develop tools, which orient the company's performance measurements to the non-financial measures in order to optimize the manufacturing performance (Gosselin, 2005).

In order to achieve the quality standards requirements of measuring the processes and continuous improvement, it is necessary to have a measuring system of efficiency and effectiveness (ISO 9001:2008; ISO/ TS 16949:2009). The most frequently used KPIs to measure the organization's performance according to these requirements are regarding human resources as: absenteeism, health rate, trainings, fluctuation; regarding processes: machines and gauges capability such: cp, cpk, cm, cmk, cg, cgk, regarding product quality such: rate of defect parts, customer complains, internal scrap.

Stamm and Neitzert (2008) propose the measurement of organizational performance using a concept consisting of five dimensions and propose therefore some specific KPIs

In the automotive industry, the original equipment manufacturers (OEM's) develop own standards such as "Formel Q-Konkret" (VW Group) or "Special Terms" (Daimler) asking for concrete indicators.

According to the Toyota philosophy, it is essential to measure the big five metrics QCDSM: Quality, Costs, Delivery, Safety and Morale (Liker & Meier, 2006).

Further on, the official KPI Institute states yearly the most popular twenty five KPIs in different domains (KPI Institute, 2013)

In total 294 indicators were identified within previous researches and quality standards requirements.

V.3. KPI pool-systematization process

V.3.1. Systematization step I: eliminating recurrences

Out of the 294 indicators found in literature survey, some were found to be identical but listed under different names. Into the doctoral research the indicators were grouped according to their significance, analyzed and their names were adapted in order to avoid recurrences. Below there is an example of how this operation was managed.

Example: KPI regarding personal trainings:

Within the analyzed literature pool, the following indicators regarding personal trainings were identified:

Table 4 *KPIs regarding personnel trainings*

Indicator	*Literature source*
Training amount	*Michalska, 2005*
Trainings registrations	*ISO: TS 16949:2009*
Times in trainings	*Bhatti et al., 2014*
Training hour per full time equivalent	*KPI Institute, 2013*
Investment for training	*Gosselin, 2005; Bhatti et al., 2014*
Expenses on workers trainings	*Michalska; 2005*

All these KPIs show the involvement of organization in employees training that why they were grouped into one single indicator. The name of this indicator is composed from the names of the five identified indicators in order to assure the traceability to the original source. The resulting indicator is: *"Training Hours/ Times in training/ Training hour per full time equivalent (FTE)/ Investment for training"* and the occurrence frequency is five, being the number of sources where this indicator can be found (Michalska, 2005; ISO:TS 16949 : 2009; Bhatti et al., 2014; KPI Institute, 2013; Gosselin, 2005).

After applying the systematization, the number of indicators was reduced from 294 to 184 KPIs.

V.3.2. Systematization step II: 3W

The following step into systematizing the KPIs consisted in grouping these indicators according to three essential questions (3W): Why, What, Who.

The indicators that resulted from the above-mentioned sources were listed within a table and grouped according to fundamental questions: "why", "what" and "who" as followed:
Why perspective regarding the KPI utility is addressed for each indicator. Accordingly this perspective, twenty three utilities were highlighted. **What** perspective assigns each indicator to the organizational area which the respective indicator is meant to measure. Therefore, seventeen organizational characteristics resulted. **Who/ whom** reffers in assigning to KPIs the perspective model suggested by Kaplan and Norton (2005). To the Kaplan's four perspectives it was added the civil society ones. Table 5 shows the proposed systematic: from five stakeholder perspectives, seventeen organizational domaines to be measured, in order to achive twenty-three organization's goals.

Table 5 KPI classification

No.	Why? Purpose/ Organizational target		What? Organizational area		Who? Perspective
1	Growing the product quality	1	Customer satisfaction	1	Customer
2	Increase the customer loyalty				
3	Increase the customer satisfaction				
4	Increase delivery reliability	2	Customer confidence		
5	Meet the customer requirements				
6	Increasing the market share	3	Market occupancy		
7	Increase employee well being	4	Employees satisfaction	2	Employees
8	Learning and growth	5	Knowledge Management		
		6	Leadership		
9	Increase work safety	7	Work safety		
10	Promote company image & assure the respecting of law requirements	8	Social/Environmental performance	3	Environment/Community
11	Cost optimization	9	Costs structure	4	Financial
12	Improve the financial dynamic	10	Dynamic of financial operations		
13	Growing profitability	11	Profitability		
14	Increase the process conformity	12	Conformity to standards	5	Internal processes
15	Improve processes dynamic	13	Process dynamic		

No.	Why? Purpose/ Organizational target		What? Organizational area	Who? Perspective
16	Increase the flexibility of processes	14	Flexibility	
17	Increase the competitivity	15	Innovation and growth	
18	Increase quality of supplied parts	16	Internal quality	
19	Increase internal quality			
20	Improve internal logistic	17	Process efficiency	
21	Increase maintenance efficiency			
22	Increase the layout efficiency			
23	Increase the production process efficiency			

V.3.3. KPI pool-systematization step III: frequency analysis

One of the challenges of this study consisted in defining a way to select the right indicators for shop floor from a pool of 184 different indicators, which were identified within previous research. Therefor the indicators mentioned in the previous chapter were filtered according to the literature sources they were mentioned in. This frequency analysis is displayed in Table 6.

Table 6 Frequency analysis

Frequency (No. of sources)	KPIs amount (No.)	KPIs (%)	Cumulate KPIs (%)	Cumulate fervency %
1	**133**	**72.28%**	**72.28%**	**6%**
2	**27**	**14.67%**	**86.96%**	**13%**
3	10	5.43%	92.39%	19%
4	5	2.72%	95.11%	25%
5	3	1.63%	96.74%	31%
6	3	1.63%	98.37%	38%
7	1	0.54%	98.91%	44%
8	1	0.54%	99.46%	50%
9	1	0.54%	100.00%	56%
10	0	0.00%	100.00%	63%
11	0	0.00%	100.00%	69%
12	0	0.00%	100.00%	75%
13	0	0.00%	100.00%	81%
14	0	0.00%	100.00%	88%
15	0	0.00%	100.00%	94%
16	0	0.00%	100.00%	100%

It is visible that 160 (133+27) KPIs were taken into consideration by fewer than 20% (max. 2 sources) of the analyzed previous research (out of which 133 KPIs were identified within only one source out of 16 literature sources analyzed and only 27 KPIs were identified in two sources). Applying the Pareto law the KPIs appearing in at least three sources will be taken into consideration to as the most appropriate (24 KPIs).

Out of the 24 KPIs with a frequency of appearance of at least three times (within three sources) the ones which were irrelevant at shop floor, for example marketing or finance related, can be eliminated:

After this elimination a pool of 18 indicators are resulted as shown in Table 7.

Table 7 Selected Indicators

Item No.	Indicator
1	Production volume (e.g. no. of produced pieces ;productivity)
2	Equipment effectiveness (OEE)
3	Duration of order execution (lead time)
4	Cycle time of the production line

5	Production processes: unplanned interruptions (duration)
6	Employees: presence/ absence / causes
7	Accident rate
8	Employee fluctuation(%)
9	Improvement ideas process (suggestions per employee)
10	Employee commitment/ engagement/cooperation/satisfaction (index)
11	Personnel: internal trainings (hours)
12	Delivered Product quality/ Failures rates /Customer complains (number. ppm)
13	Customer satisfactions: survey ratings
14	Internal quality -complains/failure rate (number. %. ppm)
15	Logistical indicators: unsupplied components
16	Logistical indicators: stocks (value. quantity)
17	Financial: savings due to process improvements
18	Costs: quality costs (scrap and repairs)

The optimal KPIs amount will be defined through a survey. Further selection will be performed through a multicriteria analyse. Therefor next steps will be defining the selection criteria and their weight (importance).

V.4. From waste to selection criteria

Organizations often forget to ask themselves questions like: "What is the use of this indicator?", "Is it useful for managing the processes ?", "Is it useful to recognize the deviations in real time ?"

In this research is proposed the application of the TPS philosophy in order to define KPI selection criteria. Similar to the waste types described in chapters above, waste regarding KPIs can be categorized by the same seven wastes defined by Ohno (1988).

Table 8 provides a brief overview of analyse and the resulted KPIs selection criteria.
The first column lists the wastes types which set the fundament of choosing the optimal KPI selection criteria, the second and third columns give an overview of the selection criteria necessary in order to avoid waste. Within the last column, literature sources where these criteria were found are listed.

Table 8 From waste to selection criteria

Waste type	Avoid action	Criteria derived from avoidance of waste:	Cj*	Literature source
Transport	Avoid "distances" between the places where the information is processed /used	Bring the processing of information in Gemba=> Select KPIs taking into consideration the possibility to be managed directly at the production place	**EOU**	Stamm & Neitzert, 2008 Piatt, 2012
Inventory (stocks)	Avoid over-information	"Produce" and handle the minimum number of indicators. select the KPIs taking into consideration the utility in processes management	**UPM**	Stamm & Neitzert, 2008 Piatt, 2012; Jung et al., 2012
Moving	Create the possibility to manage the KPIs at the production place	Select the KPIs taking into consideration the possibility to be managed directly at the production place	**EOU**	Stamm & Neitzert, 2008 Piatt, 2012
Waiting	Having available the right KPIs to drive processes	Bring the processing of information in Gemba "Produce" and handle the minimum number of indicators. select the KPIs taking into consideration the utility in process management	**EOU** **UPM**	Stamm & Neitzert, 2008 Jung et al., 2012 Piatt, 2012
Over-production	"Produce" a minimal amount of KPIs to manage processes	"Produce" and handle the minimum number of indicators. Select the KPIs taking into consideration the utility in process management	**UPM**	Stamm & Neitzert, 2008 Piatt, 2012; Jung et al., 2012
Over-processing	Reduce the resources needed to process the	Select the KPIs taking into consideration the amount of human	**UT**	

Waste type	Avoid action	Criteria derived from avoidance of waste:	Cj*	Literature source
	information	activity needed		
		Select the KPIs taking into consideration the investments in special trainings needed	**ITR**	
		Select the KPIs taking into consideration the investments in machines and software's needed	**IHS**	
Defects	Avoiding data mistakes	Select the KPIs that are familiar at the shop floor and involve the personnel	**FAM**	Liker & Meier, 2006 Groen et al., 2012 de Leeuw & van den Berg, 2011 Piatt, 2012
Not involving the employees	Involving the employees at shop floor in KPI management	Select the KPIs that are familiar at the shop floor and involve the personnel	**FAM**	Liker & Meier, 2006 Groen et al., 2012 de Leeuw & van den Berg, 2011 Piatt, 2012

*

EOU Easy of use, management facility: to have KPIs possible to be handled direct at the production line .
UPM Utility in process management. UT Update time, time necessary for data updating.
ITR Investment in trainings/ required staff qualification to manage KPIs
IHS Required investment in hardware and software
FAM Accessibility, familiarity meaning selecting simple, comprehensible and familiar KPIs for direct labor personnel.
UT Update time, time necessary for data updating

VI. Time to become lean: Model of Lean Manufacturing implementation

The "Time to become lean" model proposes the engraftment of lean manufacturing within the stages of lean and management systems of the organization. While the management system ensures the existence of the organization through satisfying quality needs, producing security and stability of the manufacturing process, the "lean" concept comes in form of an addendum to ensure the optimal quality price ratio through eliminating waste.

For this model were used two original concepts: the concept of the hard and soft tools. The hard tools are the standard TPS methods and soft tools are LM's aspects related to the human resources like: lean culture, lean thinking seen parallel and complementary to the "hard tools". These soft tools are unique in each organization and cannot be reproduced through copy & paste. Nevertheless, they have to be built parallel at each implementation step. The starting point for implement LM is the pre existence, the availability of an integrated management system, the organization's management commitment and the employees capability to learn new processes (knowledge management) as shown in Figure 5.

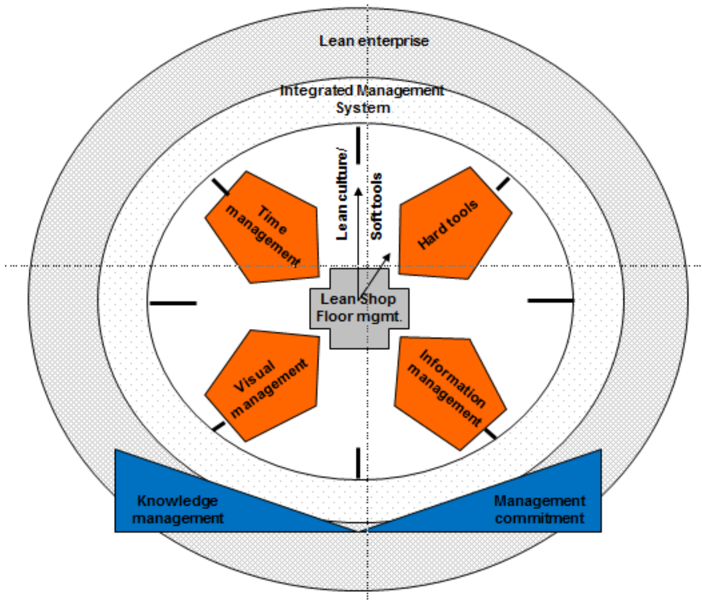


Figure 5 "Time to become lean": Lean manufacturing implementation model

VI.1. Techniques and methods: Hard tools implementation

Hard tools implementation is the step of implementing the standard lean instruments. Hard tools are defined to be all the classical lean methods and tools, as 5S, Heijunka, Kaizen, JIT, Poka Yoke, Kanban.

The "soft tools" will act in this stage through flexible choice of the most appropriate instruments for the organization and the adaption of these hard tools depending on organizational needs and avoidance of templates. Practice has demonstrated that implementing some instruments through copying even from Toyota, no matter how spectacularly efficient they have proved to be in other organizations, represents a very short termed victory

VI.2. Communication management at shop floor: Soft tool implementation

The "soft" stage of the LM implementation is the most difficult one. It is the stage where a major change is happening within the organizational culture. It is the stage of structural changes regarding human resources which happened through information (a), the visualization of the information (b) and a time management standard which allows the information flow to reach the decisional staff at the right moment (c).

a) Information Management

The "Information Management" step implies redesigning the informational management through selecting the most appropriate KPIs for measure and lead processes.

b) Visual management

Visual management focuses on redesigning the lean bases visualization in shop floor. The visualization concept must be focused on the criteria of "five minutes management instead of fifty minutes presentation" (Staufen, n.a). According to Imai (1997), a performing visual management means "the ability to understand a production zone in five minutes or less, through a simple observation, without using a computer and without talking with somebody". The aim is to design a transparent visual management system, so that the administration can recognize the need to act in a timely manner.

c) Time management

Time management consists of planning time at all hierarchical levels, standardizing this planning and focusing on the time spent in the Gemba.

Currently in most organizations, the top management reviews reports containing indicators and uses those indicators for decision-making purposes. The problem consists precisely in the fact that often these decisions are based only on those indicators, which are often in excess or text information and are not anchored in the production reality. The Gemba presence of management focused on efficient and very fast problem solving lead to a direct relationship with production employees, oriented towards optimizing processes with spectacular effects in increasing the efficiency of decision making. The manager should be perceived as the essential support factor in modifications, deviations from the normal processes and as the main trainer of their correct approach. The presence of Gemba, replacing discussions in conference rooms or offices, would result in a faster reaction to nonconformities, thus leading to the reduction of losses

VI.3. Shop floor management

The center and "heart" of the model is the shop floor management concept (SFM). This is the durable and viable "lean" organization core, SFM is in this context the set of bottom-up management standards starting from the production level all the way up to the top management level. The immediate effect is minimizing human resources consumption, followed by increasing the efficiency of the added value creating processes and personnel motivation achieved through creating a transparent management. Moreover, the effect extends to creating responsibly and involving the personnel in the effective leadership of the organization.

VI.4. Lean enterprise

When a stabilized level of lean production, organizational culture and management integrated system way of organizing is reached, the organization will position itself as a lean enterprise. This implies extending the core from SFM towards customers and suppliers. This concept derives from the Toyota philosophy and refers to aligning the relationships with entities outside the company: suppliers and customers.

The highest level of the lean enterprise takes place when the partners in the enterprise (customer - supplier) are learning together and capturing the learning in a standardized processes. This way a sustainable development is ensured throughout the entire organizational chain.

VII. Testing the actual stage of shop floor communication

In order to project the ideal model of communication at shop floor in accordance with the model "Time to become lean" a survey named "Effectiveness and Visualization at Shop Floor" was designed. For the purpose of this study the survey will be referred to as "Survey I".

Survey Design and Procedures

The questionnaire consisted of 16 questions regarding the design of the implementation steps of shop floor lean communication management: Information management, Visual management and Time Management.

VII.1. Data collection & sample profile

The questionnaire was handed out using a mailing action within automotive companies from Romania but was also posted within various specialty groups regarding lean manufacturing using the professional social media platform "LinkedIn". The survey was distributed using two different hyperlinks which served the purpose of segmenting two different types of respondents. The hyperlink to the survey was then distributed via online and social media channels. One link was distributed via the social media channel LinkedIn. The second hyperlink was distributed via an emailing action throughout production companies within the automotive sector (SNR, Takata Petri, Continental, Brandl, Compa, Harting, Wittenstein, Marquardt and Fritzmeyer). The completion of the surveys was completely anonymous. For the completion of the questionnaire, no incentive or reward was offered to the participants. Of all respondents 72% were from the automotive companies and 28% from the professional Linkedin platform. Within the data collection process, 87 surveys from a total of 157 responses were qualified to be included into the data analysis process.

The selected sample was considerated representative for a general population of employees which work in industry (96%), especially in automotive industries (80.5%) and in big companies with more than 1000 employees (77%) Furthermore, the sample represents in its majority persons working within production departments, proportionally for each hierarchical level**.**

VII.2. Step "Shop floor information management"

Questions 1 - 8

Optimal KPIs number at shop floor

The first question addresses the matter of optimal indicator number by asking the respondents to indicate the optimal number of indicators that could be read and analyzed within an effective timeframe (defined by Ohno as five minutes). The respondents had the chance to select one of the five answer choices: “one to five indicators”, “six to ten indicators”, “eleven to fifteen”, “sixteen to twenty” and “above twenty one” indicators.

The responses of 87 respondents which filled out the questionnaire presented into Figure 6.

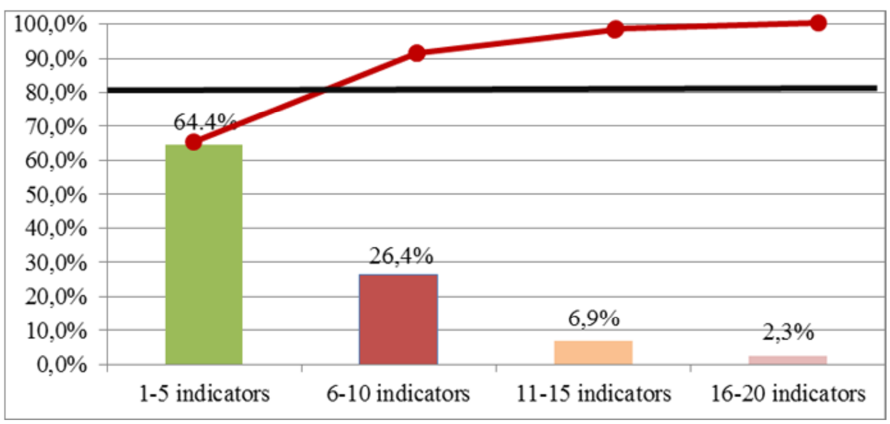


Figure 6 Pareto of optimal KPIs number

The importance of KPIs selection criteria

The second question served the purpose to assess the importance of six indicator attributes representing the selection criteria of KPIs.

All in all, all these criteria were considered to be relatively important.

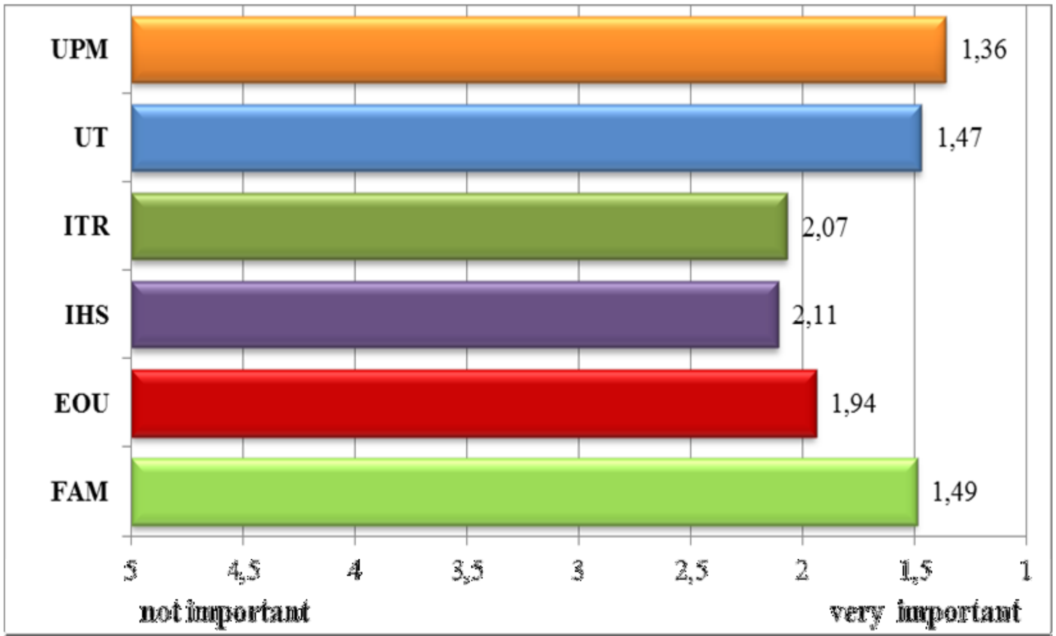


Figure 7 Weight of criteria*

**EOU* *Easy of use, management facility.*
UPM Utility in process management.
UT Update time, time necessary for data updating.
ITR Investment in trainings/ required staff qualification to manage KPIs
IHS Required investment in hardware and software
FAM Accessibility, familiarity

Analysis of KPI pool reported to each selection criterion

The fulfilling level of each indicator referred to each of the six criteria was asked in next six questions (question 3-question 8). These questions were used in combination with a Likert five-point scale.

VII.3. Testing of step "Shop floor visual management

Question 9

In order to design the shop floor visualization the participants to the previous mentioned questionnaire were asked to assess the efficiency of different nine most usual forms of visualization at shop floor. This question was used in combination with a five-point scale (1-“very efficient” to 5 -“inefficient”).

Figure 8 offers a preview of all frequency distributions for the nine visualization methods.

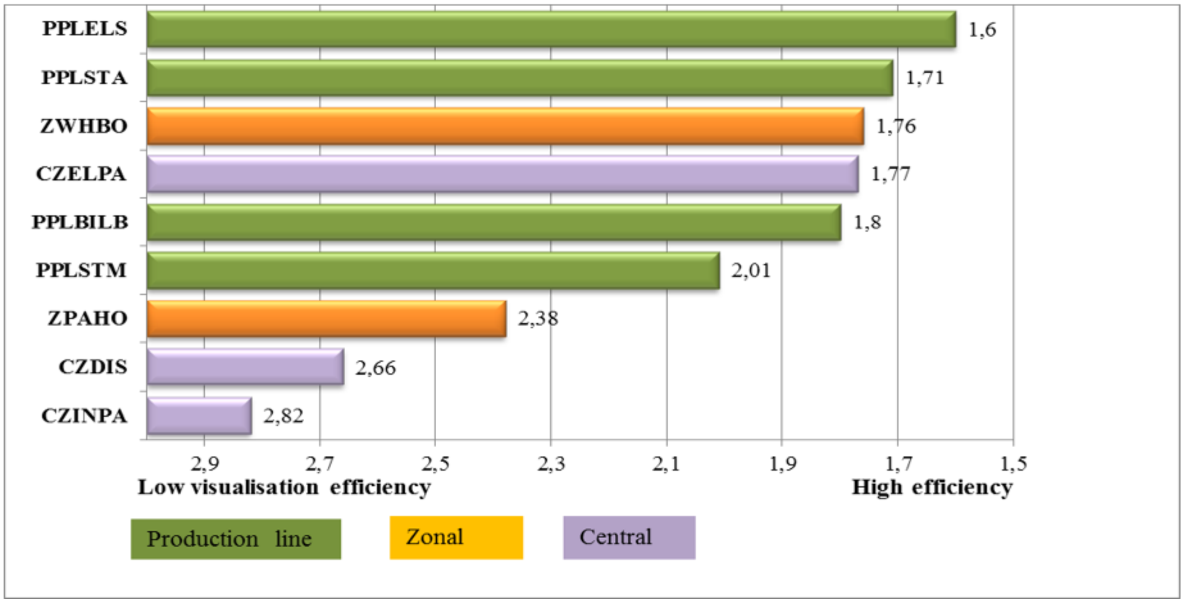


Figure 8 Effectivity of visualization methods

**CZELPA*	*Central/ zonal: panel (electronic)*
CZDIS	*Central/ zonal: displays for general information from a central computer*
CZINPA	*Central/ zonal: statistical data listed on paper and updated at least once a month*
ZPAHO	*Zonal: Paper holders (flip charts) with interactive data updated by employees*
ZWHBO	*Zonal: White board with interactive data updated daily by employees*
PPLELS	*Per production line: electronic screen and real time visualization*
PPLBILB	*Per production line: board at the end of the line based on interactive updates of employees*
PPLSTA	*Per production line: stoplight indicator. operated automatically, (ANDON)*
PPLSTM	*Per production line: stoplight indicator, operated manually. (ANDON)*

Considering the efficiency of the visualization methods, the sample who filled out the questionnaire had the following points of view regarding most efficient art of visualization at shop floor.

Production line: PPLELS, PPLSTA, PPLBILB, PPLSTM.

Production zone/central vizualization: ZWHBO, CZELPA.

The visualization methods, which should be avoided, are: CZDIS, CZINPA and ZPAHO.

VII.4. Testing of step "Shop Floor Time Management”

Questions 10 - 11

With the question 10, the respondents were asked to indicate the amount of time they spend a day for five different activities: office work, phone and email communication, meetings, at the shop floor and others.
In order to design an improved situation the question number 11 from the survey, was closely linked to the previous one, as it asked respondents to indicate what the ideal time distribution oo the previouse activities.

General conclusions

Comparing the actual time respondents spend doing office work and other activities and the ideal time that most of the staff working at shop floor the general conclusion design a lack of time spent in Gemba.The differences between ideal and actual time distribution are cumulated in Table 9.

Table 9 Differences between ideal and actual time distribution

	Office	Shop floor	Other
Production	-8.7%	19.0%	-10.3%
Quality	-9.2%	9.4%	-0.3%
Management	-8.4%	10.1%	-1.7%
Leaders	-7.4%	14.7%	-7.3%
Executive	-1.4%	-4.2%	5.6%

The most critical discrepancy between the current time allocation and the requirements can be observed for production staff and leaders. The absence of an average of 10% of the time needed to be spent at shop floor by managers and quality employees for product quality should not be neglected when it comes to a lean production.

VIII. Shop floor lean communication: project implementation

Lean shop floor communication process was implemented into an automotive multinational company in Sibiu.

At the beginning of year 2013 the situation of fulfilling the requirements of the "Time to become lean" model was as followed:

- **the pillars** of the model meaning the management commitment as also the knowledge management were already implemented

- the initial condition of existing an **integrated management system** was also fulfilled, the company in Sibiu having integrated quality- environment management system international certificated

- the first step of SFM implementation: **hard tools implementation** was integrally fulfilled (5S culture was implemented since 2008, Andon device equips all the machines in all departments, all the production lines in assembly area are Chaku-Chaku, the production planning is performed through planning Heijunka boards, the Kanban system is functional, the production lines are build according to One-Piece Flow principle, Jidoka is implemented at all end of line testers, Poka Yoke systems are available at most of workplaces).

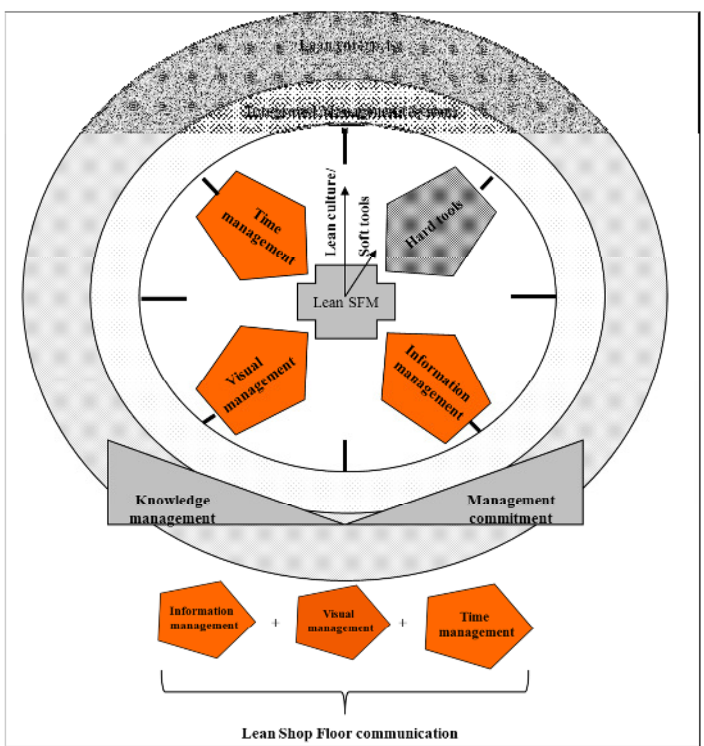


Figure 9 Shop floor lean communication in "Time to become lean" model

According to the proposed model "Time to become lean", the next step was to implement a lean shop floor communication management consisting of implementing the steps information management, visual management and time management (Figure 9).

After a stabile run, a survey regarding the employee's opinions about the effects of the project was conducted (Survey II).

VIII.1. Implementation of the step "Shop floor information management"

Through this step it was pursued to define the minimum number of KPIs at shop floor and the appropriate ones in order to avoid the waste through fewer or over information and to have the useful KPIs to lead and control shop floor processes. The selection of KPIs was performed through a multi-criteria analysis.

In order to calculate the relative weight factor for criteria, the mathematical formula below was applied:

$$kj = \mathbf{W_j/\Sigma W_j} \qquad (1)$$

j=1-6 and Σkj = 1

$\mathbf{W_j}$: Mean value of criterion "j"from Survey I

The kj values are importance factors and are listed in table 8.1.1from doctoral thesis.

Further on it was taken into consideration the level of each indicator regarding each of the six criteria, Ni (Cj) which resulted from Survey I.

The relative weight of each indicator afferent to each criterion (aij) within the multi criteria matrix in Table 10represents the product between the mean values of indicator i (Ni) for Cj criterion, Ni(Cj) and the importance factors kj.

$$aij = Ni(Cj)kj . \qquad (2)$$

where, i =1....18, j=1....6.

In Table 10 are listet the aij valuese which buil the multi- criteriadecizion matrix.

Table 10 Multi-criteria decision-making matrix

	C1	C2	C3	C4	C5	C6
	FAM	EOU	HIS	ITR	UT	UPM
kj	0.14272	0.185824	0.202	0.19828	0.1408	0.130268199
I1	0.24	0.34	0.52	0.54	0.27	0.16
I2	0.47	0.54	0.68	0.78	0.41	0.23
I3	0.41	0.47	0.61	0.73	0.38	0.22
I4	0.40	0.46	0.60	0.73	0.35	0.21
I5	0.33	0.39	0.56	0.58	0.29	0.22
I6	0.30	0.37	0.49	0.56	0.29	0.30
I7	0.28	0.35	0.45	0.58	0.24	0.33
I8	0.46	0.57	0.63	0.71	0.43	0.35
I9	0.40	0.53	0.57	0.65	0.40	0.39
I10	0.49	0.64	0.66	0.82	0.49	0.36
I11	0.45	0.59	0.64	0.78	0.45	0.38
I12	0.33	0.58	0.59	0.77	0.35	0.21
I13	0.51	0.71	0.70	0.85	0.46	0.32
I14	0.33	0.47	0.61	0.70	0.34	0.18
I15	0.43	0.53	0.61	0.63	0.37	0.23
I16	0.50	0.62	0.73	0.75	0.46	0.30
I17	0.52	0.72	0.70	0.84	0.50	0.36
I18	0.47	0.69	0.71	0.82	0.47	0.28

Based on the decision matrix table, it has been applied the utility calculation method (Resteanu, 2006).

The mathematical model used to calculate the utility is as followed:

$$u_{ij} = (a_{ij} - a^o_j)/ (a'_j - a^o_j) \qquad (3)$$

where:
u_{ij} – utility of consequences of variant "i", for criteria "j";
a'_j – the most favorable result for the criteria "C_j"
a^o_j – the most unfavorable result for the criteria "C_j"

The resulted values build the utilities matrix (table ....from doctoral thesis)

Furthermore for each "i" indicator, the synthetic utility using mathematical model was calculated:

$$Ui = \sum u_{ij} k_j \qquad (4)$$

where: u_{ij} utility for each performance indicator i for criteria j

kj importance factor

The resulted syntesys values are listed in Table 11.

Table 11 Utilities synthesis associated to performance indicators

Cj	C1	C2	C3	C4	C5	C6	Syntesis	KPI
	FAM	EOU	HIS	ITR	UT	UPM		
kj	0.143	0.186	0.202	0.198	0.141	0.130		
I1	0.00	0.00	0.23	0.00	0.11	0.00	0.062	Production volume (ex. no. of produced pieces; productivity)
I2	0.84	0.53	0.80	0.77	0.66	0.31	0.666	Equipment effectiveness (OEE)
I3	0.60	0.35	0.55	0.62	0.55	0.27	0.496	Duration of order execution (lead time)
I4	0.57	0.33	0.53	0.62	0.42	0.22	0.460	Cycle time of the production line
I5	0.31	0.14	0.38	0.14	0.19	0.24	0.233	Production processes: unplanned interruptions (duration)
I6	0.20	0.08	0.11	0.08	0.17	0.62	0.186	Employees: presence / absence / causes
I7	0.13	0.02	0.00	0.16	0.00	0.73	0.148	Accident rate
I8	0.80	0.63	0.62	0.56	0.73	0.84	0.681	Employee fluctuation %
I9	0.59	0.50	0.43	0.37	0.61	1.00	0.554	Improvement ideas process (suggestions per employee)
I10	0.89	0.81	0.75	0.91	0.98	0.88	0.863	Employee commitment/ engagement/cooperation/satisfaction (index)
I11	0.77	0.66	0.66	0.77	0.83	0.96	0.760	Personnel: internal trainings (hours)
I12	0.32	0.65	0.50	0.74	0.43	0.22	0.503	Delivered Product quality/ Failures rates /Customer complains (number, ppm)
I13	0.98	0.98	0.86	1.00	0.85	0.72	0.906	Customer satisfactions: survey ratings
I14	0.32	0.35	0.57	0.53	0.38	0.06	0.392	Internal quality -complains/failure rate(number, %, ppm)
I15	0.68	0.50	0.54	0.30	0.52	0.28	0.471	Logistical indicators: unsupplied components
I16	0.93	0.75	1.00	0.69	0.84	0.61	0.808	Logistical indicators: stocks (value, quantity)
I17	1.00	1.00	0.89	0.98	1.00	0.88	0.959	Financial: savings due to process improvements
I18	0.85	0.92	0.92	0.92	0.90	0.51	0.854	Costs: quality costs (scrap and repairs)

Taking into consideration the conclusions from Survey I regarding the selection of a minimal number of indicators (5) and a maximal one (10) , the indicators with a rank higher were analyzed and finally the selected seven indicators are I1; I7, I6, I5;I14, I15 si I12.

Table 12 Hierarchy of performance indicators

Ii	KPI	Value x
I1	Production volume (ex. no. of produced pieces; productivity)	0.062254
I7	Accident rate	0.147639
I6	Employees: presence/ absence/ causes	0.185886
I5	Production processes: unplanned interruptions (duration)	0.233114
I14	Internal quality -complains/failure rate (number; %; ppm)	0.392411
I4	Cycle time of the production line	0.45995
I15	Logistical indicators: unsupplied components	0.470792
I3	Duration of order execution (lead time)	0.496245
I12	Delivered Product quality/ Failures rates/ Customer complains (number; ppm)	0.503085
I9	Improvement ideas process (suggestions per employee)	0.553928
I2	Equipment effectiveness (OEE)	0.665638
I8	Employee fluctuation %	0.68114
I11	Personnel: internal trainings (hours)	0.760288
I16	Logistical indicators: stocks (value; quantity)	0.807537
I18	Costs: quality costs (scrap and repairs)	0.853791
I10	Employee commitment/ engagement/cooperation/ satisfaction (index)	0.862692
I13	Customer satisfactions: survey ratings	0.905953
I17	Financial: savings due to process improvements	0.95912

VIII.2. Implementation of the step "Shop floor visual management

The results of the SurveyI, stated as recommended central visualization at shop floor ZWHBO (Zonal: White board with interactive data updated daily by employees)

Since the pilot area includes about 80 production lines and taking into consideration the actual personal structure it was decided that it is possible to split the area into seven meetings corners for about 10-12 production lines to be analyzed in one corner. The lines assigned to be reported in a meeting corner are lines producing products with common characteristics (similar production technologies). A meeting corner consists of two white boards, a round discussion table and a pana board

The visualization of relevant information directly on shop floor establishes a high level of transparency for everybody. The core of the visualization consists of shop floor boards that contain KPIs, which are tracked with standardized work sheets. Due to the handwritten visualizations, employees and managers deal with the processes and problems intensely.

The structure and visualizations of the shop floor board were standardized.

a) Main Data Information (Safety sheet / Q-Green Sheet, Manpower overview)

b) Key Performance Indicators sheets

c) Visualization of priorities

d) Measures on Pana Board

VIII.3. Implementation of step "Shop floor Time Management"

The absence of an average of 20% of the time needed to be spent at shop floor by production staff followed of 15% by leaders and 10% by managers resulted from Survey I should not be neglected when it comes to a lean production. The lack of time spent at shop floor, in other words the decreased efficiency, is materialized by distortions of production, for example inadequate production flows. Therefore, within the implementation workshop, it was designed the time efficiency improvement simultaneously in two directions:

a) time rescheduling in order to increase the time interval spent in Gemba

b) increase in efficiency of the time spent in Gemba

The defined actions addressed to root causes was grouped into five categories

A. Defining a cascade with clear rules, participants from all involved functions and responsibilities, time frames

B. Bring the leaders in production: implement of go& see standard

C. Create problem solving standards: implement A3 problem solving standard

D. Scheduled standardized process control: defining standard actions/staff member/ each day and follow them up

E. Standardize the escalation process in sense of defining rules for starting the escalation, rules regarding timeframes and hierarchies succession.

IX. Project validation

In order to test the implementation success of lean shop floor communication in organization a survey was designed. The survey was filled out anonymously by employees. The developed questionnaire was distributed via hard copy to the companny's employees involved in shop floor activities. The completion of the surveys was completely anonymous. For the completion of the questionnaire, no incentive or reward was offered to the participants. Eighty five questionnaires were taken into consideration after filtering out. The analyse was performed utilizing SPSS 20.0. The survey consisted of 15 questions regarding the project.

The first two questions aimed to test if the respondents were qualified to be part of this survey. The core of the survey aimed to test the impact the project had on employees` time structure, employees` task difficulty, team spirit, decision making time and visualization methods. The first two questions were test questions in order to ensure the validity of the responses. Only employees which were part of the project were qualified to assess the process. Therefore question one asked respondents to indicate whether they know the process while the second one asked them to indicate if they were part of it.

The third question served the purpose to identify to which extent the project influenced the employees` time structure. Respondents were asked to indicate whether the time they spend on different activities increase, decreased or stayed the same. Furthermore, they were asked to estimate by which percentage the time increased or decreased

The fourth question asked respondents to indicate if the project implementation eased their duties. Those respondents who chose "yes", were asked to estimate by which percent their tasks got easier because of project implementation.

Question number five had the purpose to find out whether the project implementation improved the team spirit within the organization. The sixth question was design for testing the decision making rapidity, Respondents were asked to indicate whether the project helped to improve the speed at which they take decisions. The seventh questions aimed to assess the visualization methods used within the communication corners, asking respondents to indicate whether these visualization methods have a lower utility, a higher utility or the same utility as other visualization methods used in organization. The following seven questions served the purpose to qualify the demographical aspects of the respondents (age, experience, gender, position in organization). The last question was an open question, encouraging respondents to suggest optimization points for further project developement.

The answers indicate improvements in visualization, team spirit, facilitate of tasks difficulties, rapidity of decision, as showed in next Figure 10.

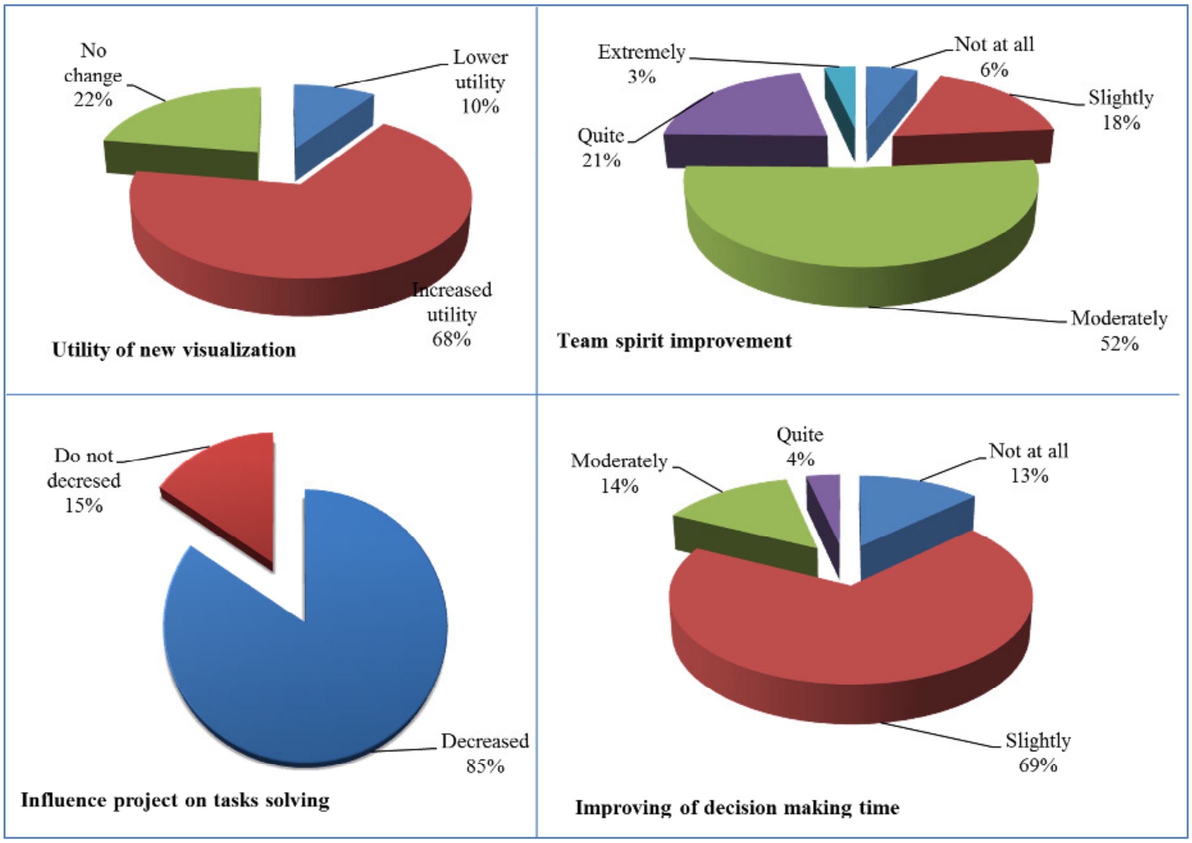


Figure 10 Effects of project implementation

IX.1. Time management improvement

Table 13 summarizes the conclusions of the analysis of the answers gathered for question three and the correlations of the answers with the hierarchical level of the respondents. The values were obtained through formula:

$$\boldsymbol{\delta = \sum_{i=1}^{N}(100\% + I_i - D_i)\,/Ni} \quad \textbf{(5)}$$

Where:

- δ The dynamics of the respective time frame (increase/ decrease of timeframe in %)
- I_i Increase (%) reported in answer i
- D_i Decrease (%) reported in answer i
- Ni Number of answers for the category

Taking into consideration the Toyota concept regarding the seven waste types, the actions 1, 4 and 6 represent wastes and therefore should be reduced/ eliminated. The purpose of the project was the reduction of these in favor of the time spent in Gemba.

Table 13 Time dynamic after implementing shop floor management

	Outside Gemba				**Inside Gemba**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	Moving to other offices	Mee-tings	Office work	Commu-nication	Analyses in production	Moving at shop floor	Trai-nings in Gemba	Others activities in Gemba
δ **Total**	-7.7%	0.5%	0.4%	-3.3%	5.1%	-3.9%	0.3%	1.1%
δ **Executive**	-3.8%	1.4%	1.6%	0.0%	6.5%	-2.3%	0.8%	1.6%
δ **Middle management**	-6.3%	-0.2%	0.6%	-2.1%	3.7%	-4.3%	1.8%	1.7%
δ **Top manage-ment**	-18.6%	-0.7%	-2.7%	-11.7%	3.9%	-7.8%	-2.6%	-0.8%

The project implementation leads to positive dynamics within the company regarding the use of time. The improvements can be broken down in:

- Reduction of "waste" time used for moving to other offices or production departments with around 7.7% and 3.9%. The impact was very strong at management level, where this type of waste was reduced by 18.6% for moving to other offices and 7.8 % for moving to other production departments;
- Reduction of the time needed to obtain information via email or telephone by 3.3% in average and by an average of 11.7% for top management and
- Increase of time for production analyses for all hierarchical levels.

IX.2. Cost savings due to the project implementation

In order to determine the real effect of the time redistribution, the first and second survey were linked together and analyzed. When time saving calculations were made, the time spent in meetings was either seen as the opposite of time spent in Gemba or not taken into consideration at all. The same approach was required for analyze of time spent for office work. This type of time was considered into the calculation as follows: first of all as being wasteful as opposite of the time spent in Gemba, secondly it was considered added value due to the necessity of office work for organization, thirdly it eliminated completely from the calculation based on the same motives as mentioned above and finally it was taken into consideration for the purpose of the calculation selectively: as added value for top management due to the fact that this category has a strong focus on developing strategies and concepts which requires a certain volume of office work; and as waste for executives and middle management due to the fact that these categories of employees need to have a strong focus on Gemba. The cases analyzed were as shown in table below:

Table 14 Calculation combinations

	Values							
Meetings	Waste	Waste	Waste	Waste	"0"	"0"	"0"	0
Office work	VAA	"0"	Waste	Combi	VAA	"0"	Waste	Combi

Waste – the time for this activity is considered waste
VAA – the time for this activity is considered a value added action
"0" - the influence of this activity on shop floor is ignored
Comb - the office work is considered as value added for management and waste for executive and middle management personnel.

As shown in the Figure 11, the different calculation types do not influence the result in a major way. The main effect of the project implementation can be observed at the top management level.

Starting from the number of employees at hierarchical levels only from work time new distribution it can be calculated financial savings starting from 4000 Euro/month to 8000 Euro/ month which represents, in the most detrimental art of calculation a financial saving of 50.000 Euro/ year.

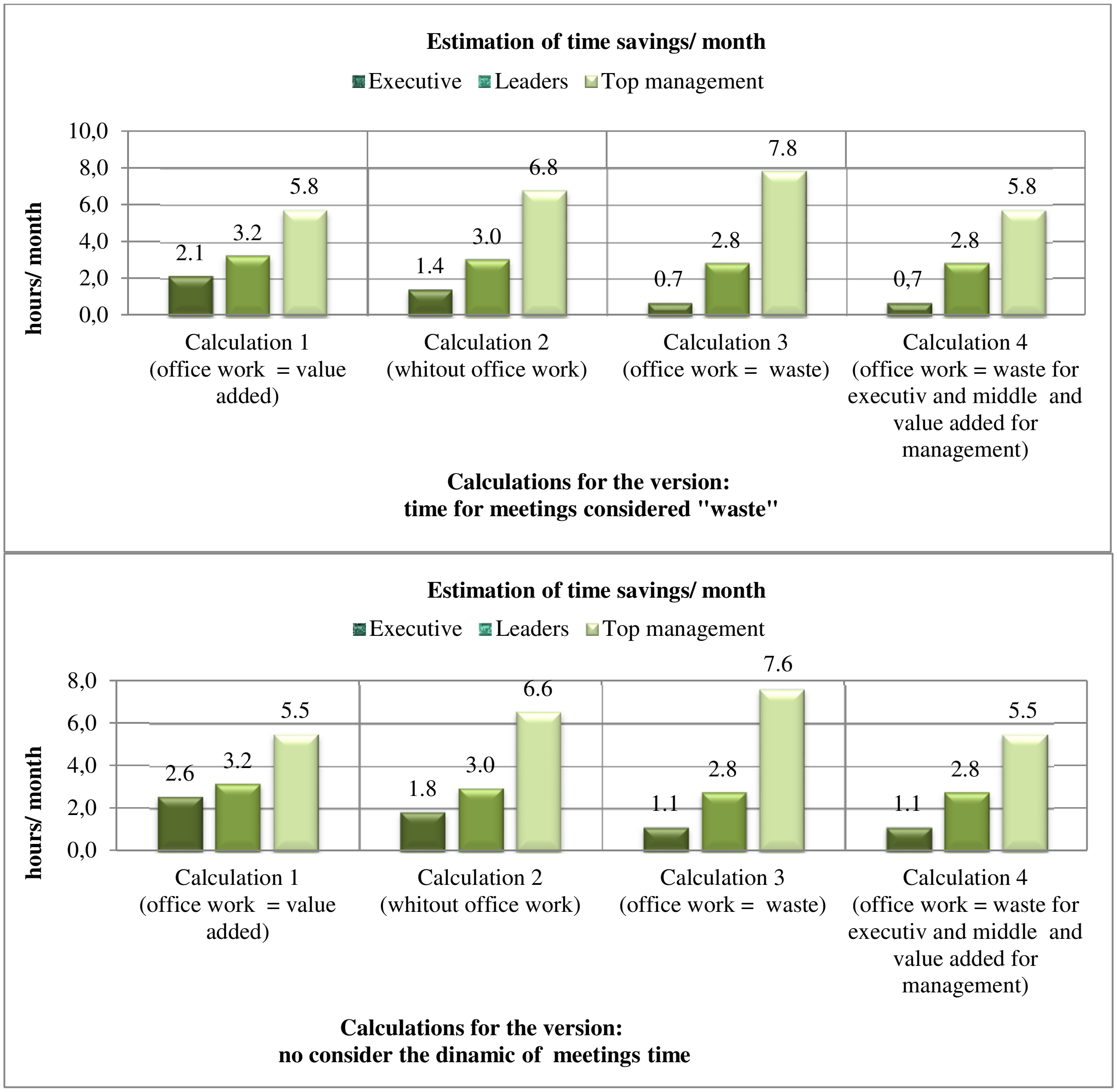


Figure 11 Estimations of time savings/ month/ personnel levels (all calculations)

X. Conclusions, limitations and further research directions

The conclusions that can be drawn following this doctoral research are in the first line conclusions resulting after the thorough literature review and second, conclusions drawn after the practical design, implementation and validation of the original lean communication model in Gemba.

First, the key to successful TPS implementation is the management and the total commitment of everyone in the organization. Together, management and employees build the **organizational culture**.

Second, lean manufacturing is much more as a set of tools which can be implemented through copy-paste but a culture which implementation and maintaining develop not only advantages for organization but also risks. Ignoring this can lead to only short time results. This was the reason why the proposed model took into consideration the organizational culture as well as the risks represented through the soft tools. The proposed model, through the approach and development of communication standards involving and motivating the staff became a self-sustained tool of shop floor management.

Thirth, the implementation of the model demonstrated that, the lean shop floor communication model can be standardized which made it viable for implementation in further companies.

Forth, the validation survey, Survey II, proved the benefits through calculating real savings and measuring employee's motivation increasing.

Fifth, the discovered difficulties encountered during the implementation of the model were: need to redefine the shop floor layout in order to build the communication corners, the new leader role for communication cascade, initialy resistance face to a new time discipline, initially lack of confidence regarding utility of efforts, lack of lean knowledge.

Sixth, the necessary strengths of implementing the concept of shop floor communication are: open minded personnel, willingness to change and adopt a new standard and good progress in the pilot phase

The opportunities created by this project are: improved discipline, higher transparency, team building and motivation and financial savings.

Regarding the limitations and further research directions, the following aspects should be addressed:

The implementation model was validated through its application into one organization. Within further research the model should be applied in more organizations and the validation conclusions should be compared. The eventual need of improvement of the model could arise after its implementations in different organizations.

The impact of the project was verified through questioning the involved staff using Survey II. Within further research the impact on direct employees must be verified using a further questionnaire.

As further research step it's proposed to analyses the current universities curricula for develop lean specialists in order to avoid the organizations waste investing time and money to educate their employees on lean so long as lean is requested every day more.

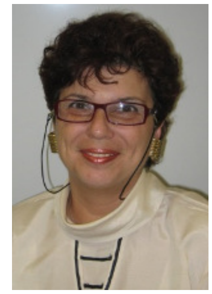
XI. Original contributions

The original contributions of the doctoral research were concretized through the following areas.

1. Synthetic analysis of influence factors and risks of LM implementation and maintenance.
2. Conclusions regarding the power and role of LM shop floor communication as leader in sustainable LM implementation
3. Proposal of the original concepts of lean "hard" and "soft" tools which represent the TPS methods versus the TPS culture.
4. Proposal of the original LM implementation model "Time to become lean".
5. Implementation of the "Time to become lean" model into an automotive organization.
6. Analysis of the actual situation (status quo) of the shop floor communication through a self-designed and self-conducted questionnaire addressed to the Romanian automotive organizations and lean practitioners.
7. Creation of a pool of KPIs with approx. 300 KPIs assed on recommended KPIs from specialty literature and standards.
8. Organization of the KPI pool through a filter method using an original 3W Concept (Why- lean filter; What – organizational area and Who- perspective)
9. Original proposal of a six criteria model to select the appropriate KPIs, starting from the seven wastes and establish of the weight factor of the six selection criteria through a questionnaire addressed to lean practitioners and automotive organizations.
10. Implementation of the communicational model into an automotive organization and defined it as standard in order to can be rolled out in other organizations
11. Development of a time management standard and quantification of the final savings due to implementation of them.

XII. Appendices

XII.1. Appendix 1 Curriculum vitae



General information

Name/surname	**Iuga, Maria Virginia**
Adress	Rennes Nr. 29 550006 Sibiu România
Phone	0040 74 59 43 06
E-mail	virginiaiuga@yahoo.com
Civil status	maried
Date and place of birth	02.10.1961 în Sibiu, România

Education
University

1980 - 1985	Polytechnic Institute of Cluj Napoca - Sibiu section : Faculty of Engineering - Manufacturing Engineering Specialty Media academic years : 9.36 Diploma Exam : 10.00

Courses and postgraduate qualifications :

2011	Environmental management systems - Inoventiv / Svasta Consulting
2011	EOQ- Quality Auditor / Authorization DE11QA - 15697 - European Organisation for Quality
2010	Optimizing production processes SCM & Lean Manufacturing - MMM Consulting Int'l
2010	VDA 6.3 process audit ed. 2010 - C.S.P.I .Bucureşti
2009	Implementation of combined management system - quality, environmental health and safety- S.C. Cometam S.R.L.
2008	Trainer Kaizen - Kaizen Institut of Romania
2008	E.O.Q- Quality Systems Manager - European Organisation for Quality
2007	Leadership development and communication - S.C. Business Service S.R.L.
2007	Wege zu umfassendem Qualitätsmanagement/ Ways of comprehensive approach to a quality management- Deutsche Gesellschaft für Qualität (DGQ)
1999	School audits - third part audit for environmental management and systems standard-ISO 14001 - SC Braco Bucureşti
1998 - 1999	Postgraduate general management , environmental management , energy vew, practice in Dortmund in a graduate fellowships for long term (1 year)- Carl Duisberg Gesellschaft eV (CDG)

Professional experience

2014-act **S.C. Marquardt Schaltsysteme SCS Sibiu**

Team leader Organizational Development

- Training Management
- Career Management
- Organizational dynamics
- Program HR business Partener

2011-2014t **S.C. Marquardt Schaltsysteme SCS Sibiu**

Operations Improvement Manager

- Planning, coordination , monitoring and reporting continued improvement program
- Leading optimization projects
- Driving workshops (TPM tact -time reduction , SMED, balancing production lines, 5S)
- Leading projects to implement new processes / streamline existing processes
- Implementation and management of process improvement ideas (MIP)
-

2005-2012 **S.C. Marquardt Schaltsysteme SCS Sibiu**

Quality&Enviroment Manager :

- Implementation and certification of the quality management system (ISO 9001. ISO / TS 16949)
- implementation and certification of environmental management due to system ISO 14001
- coordinating measurements and calibrations laboratory activity
- Coordination and ongoing internal training program in management and quality assurance
- Implementing and coordinating internal audits program (system , process , product),
- Audits in Marquardt International Concern
- representative for third-party audits Environmental &Quality

2009 – act. **Auditor DQS Romania**

Third part auditor ISO 9001

1998 - 2005 **S.C. Electrica S.A. Sibiu**

Engineer Quality and Environment

- development and implementation of quality management system in SC Electrica S.A. Sibiu , ISO 9001/2000 certification (TÜV)

1985 - 1990 **S.C. Independența S.A.**

Production Engineer:

-

Other skills and competences

Foreign languages:

German : very good
English : good
French : satisfactory

Experience / Skills:

- project management
- quality management systems / environment
- Kaizen , lean management
- International experience
- Knowledge / experience in applying quality and continuous improvement tools (FMEA , 8D , TQM , statistical methods , Kaizen , 5S etc.)
- Leadership

XII.2. Appendix 2 Scientific Activity

Scientific papers published in the proceedings of international conferences indexed ISI Web of Knowledge:

- Iuga V., Kifor C.V. & Rosca L.I. (2014). Time to become lean: The implementation model, *Proceedings ICPR-AEM-QIEM, Cluj Napoca, Romania, ISBN: 978-973-662-978-5*. 269-274

Scientific papers published in the proceedings of international conferences indexed BDI

- Iuga V., Kifor C.V. Human resources as risk factors for lean manufacturing implementation, *Proceedings: The 21st International Conference The Knowledge-Based Organization, KBO 2015, Sibiu, Romania, ISSN 1843 – 6722. 11-13 iunie 2015, pp: 229-234*

Papers published in indexed international journals:

- Iuga V., Kifor C.V. (2013). Lean Manufacturing: The WHEN, the WHERE, the WHO, *Scientific Bulletin-Nicolae Balcescu Land Forces Academy, 18(4). 401-410*
- Iuga V., Kifor C.V. (2014). Lean Manufacturing and its Transfer to Non-Japanese Organizations, *Quality-Access to Success*, *15*(139).
- Iuga V., Kifor C.V. (2014). Information and knowledge management and their inter-relationship within lean organizations, *Scientific Bulletin-Nicolae Balcescu Land Forces Academy, 19(1), 31-38.*
- Iuga V., Kifor C.V. (2014). Model of Dynamic Integration of Lean Shop Floor Management Within the Organizational Management System, *ACTA Universitatis Cibiniensis*, *65*(1), 39-45.

Scientific papers accepted for presentation in indexed ISI Web of Knowledge: conferences and papers accepted to be published in indexed international journals:

- Iuga V., Kifor C.V. & Bondrea I. Shop floor time management within the automotive industry: actual versus targeted time allocation, Paper accepted for: 2015 *International Conference QMOD-KSQM, Seoul, Korea,* ***will be held on 12-14 oct. 2015***
- Iuga V., Kifor C.V. & Rosca L.I. (2015). Lean manufacturing: Bottom up communication in management decisions, *International Multidisciplinary Scientific Conferences on Social sciences and Arts, Albena, Bulgaria,* ***will be held on 24-30 August 2015***.
- Iuga V., Kifor C.V. & Rosca L. (2015). Lean information management: selecting criteria for key performance indicators at shop floor, *Academic Journal of Manufacturing Engineering*, ***accepted***
- Iuga V., Kifor C.V. & Rosca L. (2015). Shop floor indicators in automotive organizations, *Academic Journal of Manufacturing Engineering*, ***accepted***
- Iuga V., Kifor C.V. Successful lean manufacturing implementation: internal key influencing factors, *ACTA Universitatis Cibiniensis*, ***accepted***

Lucrări ştiinţifice susţinute şi publicate la conferinţe şi simpozioane internaţionale sau cu participare internaţională

- Iuga V., Kifor C.V. & Rosca L.I. (2014).Lean Criteria for Choosing Key Performance Indicators at Shop Flool, *Joint International Conference of doctoral and post-doctoral researchers conference: Craiova, 2014: conference proceedings Bucureşti: Universitaria, 2015 4 vol.ISBN 978-606-26-0215-4, Vol. 1: ISBN 978-606-26-0216-1, 84-93*
- Iuga V., Kifor C.V. (2013).Lean Criteria for Choosing Key Performance Indicators at Shop Floor, *Proceedings: The 19th International Conference, The Knowledge--Based Organization, Sibiu, Romania, ISSN 1843-7722, 285-291.*

XIII. Bibliography

1 Acaccia, G. M., Michelini, R. C., Molfino, R. M., & Rossi, G. B. (1989). Shopfloor logistics for flexible manufacturing based on distributed intelligence. *The International Journal of Advanced Manufacturing Technology*, *4*(3), 231-242.

2 Ahrens, T. (2006). Lean production: Successful implementation of organisational change in operations instead of short term cost reduction efforts. *Lean Alliance*, *49*, 08152.

3 Allway, M., & Corbett, S. (2002). Shifting to lean service: Stealing a page from manufacturers' playbooks. *Journal of Organizational Excellence*, *21*(2), 45-54.

4 Applegate, L. M., Cash, J. I., & Mills, D. Q. (1988). Information Technology and tomorrows manager. Harvard Business Review, 66(6), 128-136.

5 Automobil-Produktion Online-Archiv (2007). *Interview mit Volker Stauch, Leitung Produktion Powertrain MB Cars und Werkleiter Untertürkheim, und Heinz-Werner Marx, Leiter Produktleistungszentrum Motoren, Werk Untertürkheim Daimler AG - Meisterschule der Lean-Lehre*. Genios. Retrieved June 21, 2014, from http://www.genios.de/fachzeitschriften/artikel/AUTO/20071201/interview-mit-volker-stauch-leitung/38889EA6A23DE4DC079D2BCF8E277E6E.html

6 Azevedo, S. G., Govindan, K., Carvalho, H., & Cruz-Machado, V. (2012). An integrated model to assess the leanness and agility of the automotive industry. *Resources, Conservation and Recycling*, *66*, 85-94.

7 Ballon, R. J. (1983). Non-Western work organization. *Asia Pacific Journal of Management*, *1*(1), 1-14.

8 Bayou, M. E., & De Korvin, A. (2008). Measuring the leanness of manufacturing systems—a case study of Ford Motor Company and General Motors. *Journal of Engineering and Technology Management*, *25*(4), 287-304.

9 Bergmiller, G. G., & McCright, P. R. (2009, May). Parallel models for lean and green operations. In *Proceedings of the 2009 Industrial Engineering Research Conference, Miami, FL*.

10 Bhatti, M. I., Awan, H. M., & Razaq, Z. (2014). The key performance indicators (KPIs) and their impact on overall organizational performance. *Quality & Quantity*, *48*(6), 3127-3143.

11 Biazzo, S. (2002). Process mapping techniques and organisational analysis: Lessons from sociotechnical system theory. *Business Process Management Journal*, *8*(1), 42-52.

12 Bicheno, J. (2004). *The new lean toolbox: towards fast, flexible flow*. Production and Inventory Control, Systems and Industrial Engineering Books.

13 Black, J., & Miller, D. (2008). The Toyota way to healthcare excellence. *ACHE Management Serie*.

14 Bondrea, I., Simon, C. & Pirvu, B. (2009). REENGINEERING AUTOMOTIVE PARTS. *Annals of DAAAM & Proceedings*.

15 Bondrea, I., Hermann, H., & Simion, C. (2007). Using sap in production planning & control for automotive manufacturing. In *International Conference on Systems. Theory and Applications*, 322-325.

16 Brans, J. P., & Mareschal, B. (1995). The PROMETHEE VI procedure: how to differentiate hard from soft multicriteria problems. *Journal of Decision Systems*, *4*(3), 213-223.

17 Brans, J. P., & Mareschal, B. (1992). PROMETHEE V: MCDM problems with segmentation constraints. *Infor*, *30*(2), 85.

18 Bumgardner, M. S. (2006). Benchmarking performance measurement and lean manufacturing in the rough mill. *Forest Products Journal*, *56*(6), 6.

19 Business Dictionary (n.d.). *Management system*. Retrieved July 17, 2015, from http://www.businessdictionary.com/definition/management-system.html.

20 Business Dictionary (n.d.). *Lean manufacturing*. Retrieved January 1, 2014, http://www.businessdictionary.com/definition/lean-manufacturing.html.

21 Clarke, C. (2005). *Automotive production systems and standardisation: from Ford to the case of Mercedes-Benz*. Springer Science & Business Media.

22 Convis, G. (2001). Role of management in a lean manufacturing environment. *Learning to think lean, 01*, *1014*, 2001.

23 Crişan, L., Popescu, S., Brad, S., & Lemeni, L. (1999). Tehnici, instrumente şi metode ale managementului calităţii.

24 Crosby, P. B. (1980). *Quality is free: The art of making quality certain*. Signet.

25 CNPIMMR (2003). *Lean Manufacturing - Metode pentru reducerea costurilor. Proiect pilot RO/03/B/F/PP-175017.* Retrieved on January 24. 2015. from: w.byweb.pt/sme/trainers/training/RO_MODUL%205%20-%20Metode%20pentru%20reducerea%20costurilor%20RO.pdf. last accessed 17.06.2014. 16-18.

26 Dankbaar, B. (1997). Lean production: denial, confirmation or extension of sociotechnical systems design?. *Human relations*, *50*(5), 567-583.

27 Davenport, T. H., & Prusak, L. (1998). *Working knowledge: How organizations manage what they know*. Harvard Business Press.

28 Davis, J. W. (2009). *Lean Manufacturing: Implementation Strategies That Work: a Roadmap to Quick and Lasting Success*. Industrial Press Inc..

29 de Leeuw, S., & van den Berg, J. P. (2011). Improving operational performance by influencing shopfloor behavior via performance management practices. *Journal of Operations Management*, *29*(3), 224-235.

30 Deming, W. E. (1944). *Statistical adjustment of data*. New York.

31 Deming, W. E. (1986). Out of the crisis Cambridge. *Massachusetts: Massachusetts Institute of Technology*.

32 Digiesi, S., Kock, A. A., Mummolo, G., & Rooda, J. E. (2009). The effect of dynamic worker behavior on flow line performance. *International Journal of Production Economics*, *120*(2), 368-377.

33 Draghici, A., & Draghici, G. (2006). *New business requirements in the knowledge-based society. Cunha, MM, Cortes BC and Putnik GD, Adaptive Technologies and Business Integration: Social, Managerial and Organizational Dimensions, Idea Group Publishing*, 211-243

34 Draghici, A., Mocan, M., & Draghici, G. (2011). On-line training and certification solution for business process managers. *In ENTERprise Information Systems* (pp. 380-389). Springer Berlin Heidelberg.

35 Esfandyari, A., & Osman, M. (2006). Success and failure issues to lead lean manufacturing implementation. Retrieved March 23, 2015, from http://www.researchgate.net/publication/266036539_Success_and_failure_issues_to_lead_lean_manufacturing_implementation.

36 Field, A. (2013). *Discovering statistics using IBM SPSS statistics*. Sage.

37 Fliedner, G., & Mathieson, K. (2009). Learning lean: A survey of industry lean needs. *Journal of Education for Business*, *84*(4), 194-199.

38 Forsythe, C., & Grose, E. (2003). Human factors in agile manufacturing. *Occupational Ergonomics: Design and Management of Work Systems*, *27*, 5.

39 Fujimoto, T. (1992). *Why do Japanese companies automate assembly operations*. Discussion paper 92-F-15 (3rd ed.) University of Tokyo.

40 Fullerton, R. R., & Wempe, W. F. (2009). Lean manufacturing, non-financial performance measures, and financial performance. *International Journal of Operations & Production Management*, *29*(3), 214-240.

41 Frost, A. (2014). *A Synthesis of Knowledge Management Failure Factors*. Retrieved March 12, 2014, from http://www.knowledge-management-tools.net/A Synthesis of Knowledge Management Failure Factors.pdf.

42 Galbraith, J. R. (1977). Organization design: An information processing view. Organizational Effectiveness Center and School, 21, 21-26.

43 Ghani, S. R. (2009). Knowledge management: tools and techniques. *DESIDOC Journal of Library & Information Technology*, *29*(6), 33-38.

44 Gilbreth, L. M. (1914). *The psychology of management: The function of the mind in determining, teaching and installing methods of least waste*. Sturgis & Walton Company.

45 Gilbreth, F., & Gilbreth, L. (1973). *Fatigue study: The elimination of humanity's greatest unnecessary waste, a first step in motion study,* Easton,Hive Pub.

46 Goodden, R. L. (2009). *Lawsuit!: Reducing the Risk of Product Liability for Manufacturers*. John Wiley & Sons.

47 Gosselin, M. (2005). An empirical study of performance measurement in manufacturing firms. *International Journal of Productivity and Performance Management*, *54*(5/6), 419-437.

48 Groen, B. A., Wouters, M. J., & Wilderom, C. P. (2012). Why do employees take more initiatives to improve their performance after co-developing performance measures? A field study. *Management Accounting Research*, *23*(2), 120-141.

49 Herron, C., & Hicks, C. (2008). The transfer of selected lean manufacturing techniques from Japanese automotive manufacturing into general manufacturing (UK) through change agents. *Robotics and Computer-Integrated Manufacturing*, *24*(4), 524-531.

50 Hicks, B. J. (2007). Lean information management: Understanding and eliminating waste. *International journal of information management*, *27*(4), 233-249.

51 Hinners, N. W. (n.d.). *Management by Wandering Around - MBWA*. Retrieved June 2, 2014, from http://www.pmhut.com/management-by-wandering-around-mbwa.

52 Hobbs, D. P. (2003). *Lean manufacturing implementation: a complete execution manual for any size manufacturer*. J. Ross Publishing.

53 Horská, E., Ürgeová, J., & Prokeinova, R. (2011). Consumers' food choice and quality perception: Comparative analysis of selected Central European countries. *Agric. Econ.–Czech*, *57*, 493-499.

54 Imai, M. (1997). *Gemba Kaizen: A Commonsense, Low-Cost Approach to Management: A Commonsense, Low-Cost Approach to Management*. McGraw Hill Professional.

55 INTERNATIONAL STANDARD ISO 9001. (2008). Quality management systems - Requirements (ISO 9001:2008), EN ISO 9001:2008.

56 INTERNATIONAL STANDARD ISO:TS 16949. (2009). *Quality Management Systems- Particular requirements for the application of ISO 9001:2008 for automotive production and relevant service parts production* (ISO:TS 16949:2009), EN ISO:TS 16949:2009.

57 INTERNATIONAL STANDARD ISO 9000. (2005). *Quality management systems - Fundamentals and vocabulary* (ISO 9000:2005), EN ISO 9000:2005.

58 Iuga, V., Kifor, C.V. (2013). Lean manufacturing – Trend or actual improvement requisite. *Proceedings International Conference KBO, AFT Sibiu.*

59 Iuga, V., & Kifor, C. V. (2014). Information and knowledge management and their inter-relationship within lean organizations. Scientific Bulletin-Nicolae Balcescu Land Forces Academy, *19*(1), 31.

60 Iuga, M. V., Kifor, C. V. & Rosca, L.. I. (2015). Lean manufacturing: Bottom up communication in management decisions. *International Multidisciplinary Scientific Conferences on Social sciences and Arts, Albena*.

61 Iuga, V., & Kifor, C. (2014). Model of Dynamic Integration of Lean Shop Floor Management Within the Organizational Management System. *ACTA Universitatis Cibiniensis, 65*(1), 39-45.

62 Iuga, M. V., & Kifor, C. V. (2014). Lean Manufacturing and its Transfer to Non-Japanese Organizations. *Quality-Access to Success*, *15*(139).

63 Iuga, V., Kifor, V. & Rosca L. (2014). Time to become lean: The implementation model, *Proceedings ICPR-AEM-QIEM, Cluj Napoca, Romania,ISBN: 978-973-662-978-5*, 269-274.

64 Jackson, T. L., & Jones, K. R. (1996). *Implementing a lean management system*. Productivity press.

65 Johansson, T., Moehler, R. C., & Vahidi, R. (2013). Knowledge sharing strategies for project knowledge management in the automotive sector. *Procedia-Social and Behavioral Sciences*, *74*, 295-304.

66 Jung, J., Lee, J., Jung, J., Kim, S., & Shin, D. (2012). A Methodology of Collaborative Performance Measurement for Manufacturing Collaboration. *International Journal of Industrial Engineering: Theory, Applications and Practice, 19*(3), Retrieved July, 23, 2015 from http://journals.sfu.ca/ijietap/index.php/ijie/article/view/592.
67 Juran, J. M. (1954). Universals in management planning and controlling. *Management Review*, *43*(11), 748-761.
68 Juran, J. M. (1986). The quality trilogy. *Quality Progress*, *19*(8), 19-24.
69 Kakabadse, N., Kouzmin, A., & Kakabadse, A. (2001). From tacit knowledge to knowledge management: leveraging invisible assets. *Knowledge and process management*, *8*(3), 137-154.
70 Kaplan, R., & Norton, D. (2005). The balanced scorecard. *Harvard business review*, *84*(3), 100-109.
71 Kato, T., & Owan, H. (2011). Market characteristics, intra-firm coordination, and the choice of human resource management systems: Theory and evidence. *Journal of Economic Behavior & Organization*, *80*(3), 375-396.
72 Keating, E., Oliva, R., Repenning, N., Rockart, S., & Sterman, J. (1999). Overcoming the improvement paradox. *European Management Journal*, *17*(2), 120-134.
73 Kebede, G. (2010). Knowledge management: An information science perspective. *International Journal of Information Management*, *30*(5), 416-424.
74 Kettinger, W. J., & Grover, V. (1995). Special section: toward a theory of business process change management. *Journal of Management Information Systems*, 9-30.
75 Kifor, C. V., & Oprean, C. (2002). Ingineria calităţii. *Editura Universităţii „Lucian Blaga", Sibiu.*
76 Kifor, C. V., & Oprean, C. (2006). *Ingineria calităţii: îmbunătăţirea 6 sigma*. Editura Universităţii" Lucian Blaga".
77 Kifor, C. V., Oprean, C., Georgescu, N. & Negulescu, S. C. (2009). Engineering Education: Dense Teaching for Life-Long Learning. In *Proc. of the Balkan Region Conference on Engineering and Business Education & International Conference on Engineering and Business Education, Sibiu*, 659-665.
78 Kotter, J. P. (1996). *Leading change*. Harvard Business Press.
79 KPI Institute (2013). *Index of /wp-content/uploads/2013/covers/2011-2012*. Retrieved August 18, 2014, from http://kpiinstitute.org/wp-content/uploads/2013/covers/2011-2012/.
80 Krichbaum, B. D. (2007). Establishing Lean Metrics–Using the Four Panel Approach as a Foundation for a Lean Scorecard.
81 LeanRomania Weblog. (n.d.). Retrieved February 23, 2015, from http://leanromania.wordpress.com.
82 Lean Manufacturing Improvements (n.d.). *Case Studies/Results*. Retrieved January 1. 2014. http://www.tpslean.com/resultsall.htm.
83 Lewin, K. (1946), Force field analysis. *The 1973 Annual Handbook for Group Facilitators*, 111-13.
84 Liker, J. (2004). *The Toyota way: 14 management principles from the world's greatest manufacturer*. New York: McGraw-Hill.
85 Liker, J., & Meier, D. (2006). *The Toyota way fieldbook: A practical guide for implementing Toyota's 4Ps*. New York: McGraw-Hill.
86 Lila, B. (2012). A survey on implementation of the lean manufacturing in automotive manufacturers in the eastern region of Thailand. In *2nd international conference on industrial technology and management (ICITM 2012), IPCSIT* (Vol. 49).
87 Lillrank, P. (1995). The transfer of management innovations from Japan. *Organization studies*, *16*(6), 971-989.
88 Losonci, D., Demeter, K., & Jenei, I. (2011). Factors influencing employee perceptions in lean transformations. *International Journal of Production Economics*, *131*(1), 30-43.
89 MacDuffie, J. P., & Pil, F. K. (1995). The international assembly plant study: Philosophical and methodological issues. *Lean Work: Empowerment and Exploitation in the Global Auto Industry, Wayne State University Press, Detroit*, 181-198.
90 MacDuffie, J. P., & Krafcik, J. (1992). Integrating technology and human resources for high-performance manufacturing: Evidence from the international auto industry. *Transforming organizations*, 209-226.
91 Malhotra, Y. (2001). From Information Management to Knowledge Management. Beyond the'Hi-Tech Hidebound'Systems. *Knowledge Management and Business Model Innovation. Idea Group Publishing*,

115-134.
92 Matsushita, K. (1988). The secret is shared. *Manufacturing Engineering*, *100*(2), 15.
93 Md, K. A., Kumar, R., Mosharraf, M., Mondal, P., & Islam, S. A. (2012). Implementation of Lean Tools in RMG Sector through Value Stream Mapping (VSM) For Increasing Value-Added Activities.
94 Michalska, J. (2005). The usage of The Balanced Scorecard for the estimation of the enterprise's effectiveness. *Journal of Materials Processing Technology*, *162*, 751-758.
95 Miller, G., Pawloski, J., & Standridge, C. R. (2010). A case study of lean, sustainable manufacturing. *Journal of industrial engineering and management*, *3*(1), 11-32.
96 Miller, L. (2011). *Lean Culture and Leadership Factors A Survey of Lean Implementers' Perceptions of Execution and Importance*. Retrieved July 2, 2014, from http://www.lmmiller.com/wp-content/uploads/2011/06/Report-Lean-Culture-and-Leadership-Factors4.pdf
97 Motwani, J. (2003). A business process change framework for examining lean manufacturing: a case study. *Industrial Management & Data Systems*, *103*(5), 339-346.
98 Mowday, R. T., Steers, R. M., & Porter, L. W. (1982). Employee-Organizational Linkages: The Psychology of Commitment, Turnover, and Absenteeism.
99 Nonaka, I., & Takeuchi, H. (1995). The knowledge creation company: how Japanese companies create the dynamics of innovation.
100 Nordin, N., Deros, B. M., & Wahab, D. A. (2010). A survey on lean manufacturing implementation in Malaysian automotive industry. *International Journal of Innovation, Management and Technology*, *1*(4), 374-380.
101 Ohno, T. (1982). The origin of Toyota production system and kanban system. In *Proceedings of the International Conference on Productivity and Quality Improvement*.
102 Ohno, T. (1988). Toyota production system: beyond large-scale production. Diamond. *Inc., Tokyo*.
103 Olaru, M., Isaic-Maniu, A., Lefter, V.; Pop, N.A., Popescu, S., Dragulanescu, N., Roncea, L. & Roncea, C. (2000). *Tehnici si instrumente utilizate în managementul calităţii*, Editura Economică, Bucuresti.
104 Oprean, C., Kifor, C. V., & Magadoiu, A. (2011). Aplicaţii ale sistemelor Poka Yoke în producţia de componente electronice pentru industria auto. *Quality-Access to Success*, *12*(5).
105 Oprean, C., Kifor, C. V., & Suciu, O. (2005). Managementul integrat al calitatii. *Editura universitatii Lucian Blaga Sibiu*.
106 Pardy, W., & Andrews, T. (2009). *Integrated Management Systems: Leading Strategies and Solutions*. Government Institutes.
107 Pareto, V. (1935). *The mind and society*. Рипол Классик.
108 Patriotta, G., & Brown, A. D. (2011). Sensemaking, metaphors and performance evaluation. *Scandinavian Journal of Management*, *27*(1), 34-43.
109 Peters, R. (2009). Shopfloor-Management: Führen am Ort der Wertschöpfung. LOG_X.
110 Phillips, E. J. (2002). *The Pros and Cons of Lean Manufacturing for the Small to Medium Size Fabrication Shop. The Sims Consulting Group, available at: http://www. simsconsult. com/ProsConsLeanManuf/FORMFAB2. pdf, last accessed on: 20.11.*2013.
111 Piatt, J. (2012). OPERATIONS-5 Rules for Selecting the Best KPIs to Drive Operational Improvement-The key to success is selecting KPIs that will deliver long-term value to the organization. *Industry Week-Cleveland*, *261*(11), 30.
112 Ping-yu, Y. (2009). The barriers to SMEs implementation of lean production and its countermeasures–based on SMEs in Wenzhou. Reform Strategy, 1, 148-151.
113 Porsche AG (2013). *Annual Report 2012*. . Retrieved December 28, 2013, from http://www.volkswagenag.com/content/vwcorp/info_center/en/publications/2013/03/Porsche_Annual_Report_2012.bin.html/binarystorageitem/file/Porsche-Download_e.pdf.
114 Powell, M. (2003). *Information management for development organisations*. Oxfam.
115 Prakken, B. (2012). *Information, organization and information systems design: an integrated approach to information problems*. Springer Science & Business Media.
116 Puvanasvaran, P., Megat, H., Hong, T. S., & Razali, M. M. (2009). The roles of communication process for an effective lean manufacturing implementation. *Journal of industrial engineering and management*, *2*(1), 128-152.

117 Rahman, S., Laosirihongthong, T., & Sohal, A. S. (2010). Impact of lean strategy on operational performance: a study of Thai manufacturing companies. *Journal of manufacturing technology management*, *21*(7), 839-852.
118 Reitz, A. (2008). Lean TPM. *München: Moderne Industrie-Verlag*.
119 Resteanu, C. (2006). „MADM. Teorie şi practică".
120 Rich, N., Bateman, N., Esain, A., Massey, L., & Samuel, D. (2006). *Lean evolution: lessons from the workplace*. Cambridge University Press.
121 Rinehart, J. W., Huxley, C. V., & Robertson, D. (1997). *Just another car factory?: Lean production and its discontents*. Cornell University Press.
122 Rose, A. M. N., Deros, B. M., & Rahman, M. A. (2010). Development of framework for lean manufacturing implementation in SMEs. In *The 11th Asia Pacific industrial engineering and management systems conference, Melaka, Malaysia*.
123 Rose, A. M. N., Deros, B. M., Rahman, M. A., & Nordin, N. (2011). Lean manufacturing best practices in SMEs. In *Proceedings of the 2011 International Conference on Industrial Engineering and Operations Management* (pp. 872-877).
124 Roy, B. (1968). Classement et choix en présence de points de vue multiples (la méthode ELECTRE), Rev. Française Automat., Informat. *Recherche Opérationnelle*, *8*.
125 Sawhney, R., Teparakul, P., Bagchi, A., & Li, X. (2007). En-Lean: a framework to align lean and green manufacturing in the metal cutting supply chain. *International Journal of Enterprise Network Management*, *1*(3), 238-260.
126 Shadur, M. A., Rodwell, J. J., & Bamber, G. J. (1995). Factors predicting employees' approval of lean production. *Human Relations*, *48*(12), 1403-1425.
127 Shah, R., & Ward, P. T. (2003). Lean manufacturing: context, practice bundles, and performance. *Journal of operations management*, *21*(2), 129-149.
128 Shetty, D., Ali, A., & Cummings, R. (2010). Survey-based spreadsheet model on lean implementation. *International Journal of Lean Six Sigma*, *1*(4), 310-334.
129 Shingo, S. (1988). *Non-stock production: the Shingo system of continuous improvement*. Productivity Press.
130 Shingo, S. (1985). *A revolution in manufacturing: the SMED system*. Productivity Press.
131 Shingo, S., & Dillon, A. P. (1989). *A study of the Toyota production system: From an Industrial Engineering Viewpoint*. Productivity Press.
132 Shukla, A. (2005). FAT results from Lean implementation. *Plant Engineering*, *59*(10), 31.
133 Stamm, M., & Neitzert, T. (2008). Key Perfromance Indicators (KPI) for the implementation of lean methodologies in a manufacture-to-order small and medium enterprise.
134 Staufen (n.a.). *Shopfloor Management.* Retrieved June 15, 2014, from http://www.staufen.ag/fileadmin/Brochures/brochure-staufen-shopfloor-management-en.pdf.
135 Strategosic (n.d.). *A Brief History of Lean*. Retrieved October 11, 2013, from http://www.strategosinc.com/just_in_time.html.
136 Streb, C. K., & Gellert, F. J. (2011). What do we know about managing aging teams? Lessons learned from the automotive shop floor. *Organizational Dynamics*, *40*(2), 144-150.
137 Taylor F. W. (1911). The principles of scientific management. *New York & London: Harper Brothers*.
138 Taylor, M., & Taylor, A. (2008). Operations management research in the automotive sector: Some contemporary issues and future directions. International Journal of Operations & Production Management, 28(6), 480-489.
139 Terra, J. C., & Angeloni, T. (2003). Understanding the difference between information management and knowledge management. *TerraForum, Consultores, Toronto, ON, Canada, M4L 3S5*.
140 Teufel, P. (2005). *Toyota - Ein Unternehmen permanent am Limit*. Retrieved January 27, 2014, from http://www.shopfloor-management.de/content/view/20/38/.
141 The Deming Institute. (n.d.). Retrieved April 6, 2012, from https://deming.org/.
142 Thun, F. S. V. (1981). Miteinander reden: Störungen und Klärungen. *Psychologie der zwischenmenschlichen Kommunikation. Reinbek bei Hamburg*.

143 Thun, J. H., Lehr, C. B., & Bierwirth, M. (2011). Feel free to feel comfortable—an empirical analysis of ergonomics in the German automotive industry. *International Journal of Production Economics*, *133*(2), 551-561.
144 Upadhye, N., Deshmukh, S. G., & Garg, S. (2010). Lean manufacturing for sustainable development. *Global Business and Management Research*, *2*(1), 125.
145 Vatalaro, J., Taylor, R., & Taylor, R. E. (2005). *Implementing a mixed model Kanban System: The lean Replenishment Technique for pull production* (Vol. 1). Productivity Press.
146 Von Axelson, J. (2009). Developing lean production implementation methodology for SME learning networks. In *16th International Annual EurOMA Conference, Göteborg, Sweden* (pp. 14-17).
147 Wang, J. X. (2010). *Lean manufacturing: Business bottom-line based*. CRC Press.
148 Weston, M. (2002). *Giants of Japan: The lives of Japan's greatest men and women*. Oxford University Press.
149 Wheatley, M. (2005). Think lean for the long term: IT can make the journey smoother, but not without corporate commitment. *Manufacturing Business Technology*, *23*(6), 36-38.
150 Wiig, K. M. (1999). Introducing knowledge management into the enterprise. *Knowledge management handbook*, 3-1.
151 Wilkens, U., & Pawlowsky, P. (1997). Human resource management or machines that change the world in the automotive industry?. *MIR: Management International Review*, 105-126.
152 Wilson, J. R. (2003). Support of opportunities for shopfloor involvement through information and communication technologies. *AI & SOCIETY*, *17*(2), 114-133.
153 Wolf, D. (2008). The Electric Shock: Electric Cars Pre-Date the Civil War!, Retrieved October 11, 2013, from http://mentalfloss.com/article/18852/electric-shock-electric-cars-pre-date-civil-war
154 Womack, J. P., & Jones, D. T. (2010). *Lean thinking: banish waste and create wealth in your corporation*. Simon and Schuster.
155 Womack, J. P., Jones, D. T., & Roos, D. (1990). *Machine that changed the world*. Simon and Schuster.
156 Worley, J. M., & Doolen, T. L. (2006). The role of communication and management support in a lean manufacturing implementation. *Management Decision*, *44*(2), 228-245.
157 Yi, G. R., Shin, J., Cho, H., & Kim, K. J. (2002). Quality-oriented shop floor control system for large-scale manufacturing processes: Functional framework and experimental results. *Journal of Manufacturing Systems*, *21*(3), 187-199.
158 Zhang, K. (2012). Using visual languages in management. *Journal of Visual Languages & Computing*, *23*(6), 340-343.
159 Zhang, W., & Deuse, J. (2009). Cell staffing and standardized work design in Chaku-Chaku production lines using a hybrid optimization algorithm. In *Computers & Industrial Engineering, 2009. CIE 2009. International Conference on* (pp. 305-310). IEEE.
160 Zuckerman, A., & Buell, H. (1998). Is the world ready for knowledge management?. *Quality Progress*, *31*(6), 81.