

A New MAS Based Approach Modeling the QMS Continual Improvement.

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Abstract— The purpose of this paper is to model a Quality Management System (QMS) based on Multi-Agent System (MAS). Our model has been carried out through three phases; first an identifying process of ISO 9000, ISO 9001 and ISO 9004 standard has been performed, then a brief recall on the MAS has been realized. Finally, we propose a new approach that models a QMS throw MAS. The different steps of the proposed approach cover the whole PDCA (Plan, Do, Check, Act) scheme.

Keywords— Modelling, MAS, QMS, process approach, continual improvement, PDCA

I. INTRODUCTION

The current economic context forces the companies to be creative, agile, reactive, and to be surpass face a fierce competition. Therefore, it they push to confront the hardenings market, to accelerate the changes, to increase the complexities and to improve their performances. In this particularly unstable and competing context, the companies seek to reconfigure their structures and organizations on operational processes directly [1] or on construction of enterprise software systems [17]. This dynamics is articulated around three principal axes: the costs and deadlines reduction [4], the dysfunctions intern company limitation and especially the customers satisfaction increase [18]. This fact, the QMS installation becomes a real challenge and a favourable framework for adapting the desired progress dynamics [2].

Many research showed that the more adapted system is based on the process approach [3]. In this context, some data mining and artificial intelligence technologies have been carried out to contribute to this and are highly effective in addressing many engineering solutions like developing applications for mobile phones, wireless devices with limited memory, processing power, and graphical capabilities [15] [16]. H.C.W Lau and al. developed an intelligent QMS using the fuzzy association rules [5]. Indeed, the objectives are effectively attained, if the activities are managed by processes within a system approach where the processes inter act. This is even more confirmed if we note that the ISO 9001 standard [7] requires the process approach adoption. It also requires the interactions definition between the processes to achieve the coherent objectives.

To conform to these normative requirements, the organizations must adopt a methodology for putting in place this processes approach [14]. To deal with, we

proposed to apply the Multi agents concept [10] to the QMS modelled by processes. This guidance finds its entire meaning seen the similarity between the MAS and the process interactions systems.

In order to better illustrate this approach, this paper proposes a new approach that models a QMS throw MAS. The different steps of the proposed approach cover the whole PDCA (Plan, Do, Check, Act) scheme.

This paper is divided into four main sections. Section two presents a generic study of the QMS and MAS. The QMS design based on the MA concept are described with the detailed explanation in Sections 3. Final section concludes the entire paper by presenting the key findings and future work.

II. GENERIC STUDY OF THE QUALITY MANAGEMENT SYSTEMS AND THE MULTI AGENT SYSTEMS

A. *The Quality Management Systems study*

The QMS are designed to permanently improve the effectiveness and efficiency of the organizations performances. As such, the ISO 9001 standard [7] sets the QMS requirements to achieve the customer satisfaction effectively. This standard used for the organizations certification is articulated around continual improvement logic. Within a complementary framework, we find the ISO 9004 standard [8] which has wider quality management objectives and which include the other interested parts satisfaction such as the personnel, the suppliers and the owners, and this, in an effective and efficient way. This standard perfectly compatible with the ISO 9001 [7] can be used as guides for continual performances improvement.

The QMS implementation needs the taking into account of the interested parts expectations and requirements [9]. That can result in coherent and measurable objectives functional and operational that the organization direction will be fixed and planned. Based on these, it is necessary to model the system structure which can reply to the effectiveness and efficiency. It is in this perspective that we must identify the processes that can provide added value and to ensure the controlled and permanent piloting processes in interactions.

By analyzing Fig.1 and basing on ISO 9000 [6], ISO 9001 [7] and ISO 9004 [8] standards, we can synthesize the requirements into four categories:

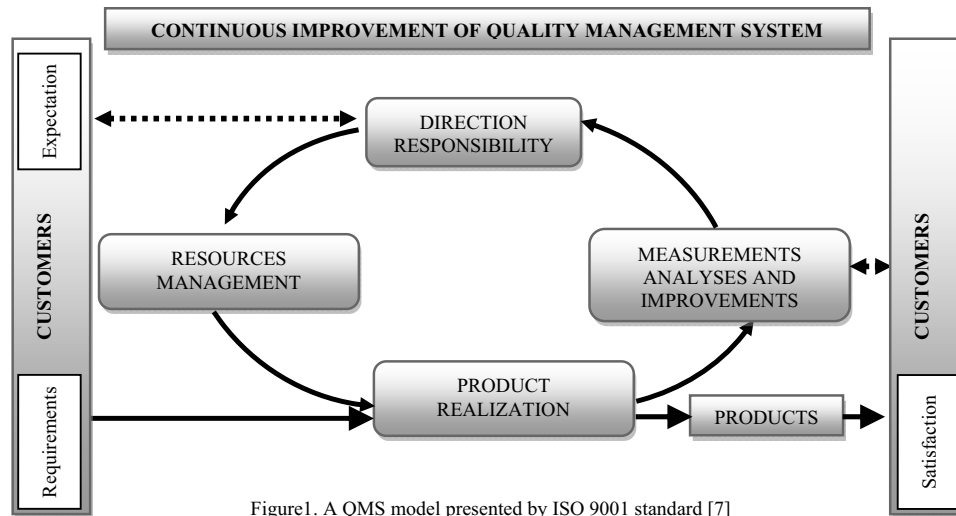


Figure1. A QMS model presented by ISO 9001 standard [7]

- **The direction responsibilities** which retains that it must principally satisfy the following requirements:

- The customers and interested parts listening and expectations identification.
- The coherent and measurable and planned objectives definition.
- The policy implementation which includes the continual improvement.
- The human and material resources provide allowing to attain the objectives and to satisfy the customers.
- The internal communication.
- The responsibilities definition.
- The direction reviews to collect the results, to rectify the objectives, to provide additional resources and to confirm the improvement needs.

- **The resources management** which can guarantee the customers satisfaction increase, the effectiveness and efficiency as well as the continual improvement. This thus implies:

- The competence and knowledge needs identification for to make which affect product conformity.
- The competences acquisition by the formation or recruitment.
- The competences evaluation.
- The infrastructure needs identification which affect products conformity.
- The infrastructures provide.
- The infrastructures and the work environment service and maintenance which ensures the products conformity.

- **The product realization** which includes all the stages and process making it possible to carry out the products and to provide them to the customers. This includes mainly the following requirements:

- The products realization planning by considering the objectives, the resources and methods as well as the customer expectations.
- The requests and the orders feasibility study.
- The communication with the customers and their complaints treatment.
- The design activities planning by considering the input and output data, the checks, the reviews and the validations.
- The purchases management with the good quality specifications and the suppliers evaluation.

- The production activities control with considering the traceability, the identification, the safeguarding and the products storage.
- The measuring instruments calibration.

- **Measurements, Analyses and Improvements** which constitute the monitoring process to start a QMS improved. In this context, the principal identified requirements are:

- The measurement and monitoring customer satisfaction.
- The audits realization on conformities and effectiveness.
- The products conformity control.
- The processes efficiency measure.
- The measurement and monitoring data analysis.
- The corrective and preventive adequate actions starts and the continuous improvement insurance.

While referring to the requirements identified and to the process approach bases we can identify five process types namely:

- *A direction process* which will take to listen in the customers expectations and the objectives definition, the resources provider, the decision-making and the improvements action confirmation.

- *A stock management process* which will concern to identify the necessary resources, the human resources competence insurance, the infrastructures maintenance and the work environment.

- *A realization process* which will get to take into account the customers requirements and will ensure the production planning by respecting the products requirements.

- *A monitoring process* which will focus on the products controls, the nonconformity detection and the performances measurement processes [13] to allow decision-makers to define appropriate corrective actions in order to reach up all the objectives.

- *A continues improvement process* which will dedicate to analysis the monitoring results and which will propose the corrective and preventive actions and adequate improvement.

It is very important to say that these processes work each one in PDCA logic in order to take part effectively in the objectives attack which theirs are fixed.

B. The Multi Agents Systems study

For Ferber an agent is "an autonomous entity, real or abstracted, evolving, which is able to act on itself and its

environment, which can communicate with other agents, and whose behavior is the consequence of its observations, its knowledge and the interactions with other agents" [11]. Each agent is its own competent, but it needs to interact with the others to solve the problems which depend on its expertise field and to avoid the conflicts. These systems objective is to find a solution with global problems or to simulate complex behaviors using whole agents having the following properties:

- Autonomy (the agent acts without the human or other agents intervention),
- The pro-activity (the agent has its own activity and its own object) and the adaptation (the agent is able to control his aptitudes).

A MAS is a distributed system composed whole agents. It is conceived and established like whole agents interacting under the cooperation, competition or coexistence modes [12]. We speak then about MAS in which the agents will have to interact for:

- To communicate directly between them, by another agent intermediary or by acting on their environment and to work together for the common object resolution, we then speak about the cooperation concept.
- To allocate the various tasks, we speak about the collaboration concept.
- To organize the resolution of a problem so that the delicate interactions (harmful) are prevented or that the beneficial interactions are exploited, we then speak about the coordination concept.
- To manage an agreement acceptable for all the parts concerned, we then speak about the negotiation concept.

With this stage we can confirm that the process approaches, the QMS and the MAS present a lot of similarities in the way that can make *corresponds a process*

to one or many agent. By considering the requirements identified of ISO 9001 standard [7], we can engage the *QMS-MAS structuring model*.

III. QUALITY MANAGEMENT SYSTEM DESIGN BASED ON THE MULTI AGENT CONCEPT

In this part, we propose our new approach which is interested in the MA concept application on the QMS. Indeed, we see similarities between the process and agent concept. On the one hand, the processes have objectives, interact, communicate, supervise and improve through action plans. In the other hand, the agents have objectives, cooperate, coordinate and act in order to lead their objectives.

The idea consists in modeling each process identified in section 2, where the different steps cover the PDCA (Plane, Do, Check and Adjust) scheme. Each PDCA stage will be symbolized by four agents knowing that this representation differs from a process to another. This approach is schematized in Fig.2.

Each process and their interactions will be thereafter detailed in the following tables (Table 1 to 5) by giving each agent their role and significance on QMS. Indeed, a number of agent will intervene in this QMS such as agents related to: (1) direction process with P1, D1, C1 and A1, (2) human and material resources management process with P2, D2, C2 and A2, (3) product realization process with P3, D3, C3 and A3, (4) monitoring process with P4, D4, C4 and A4, (5) measurements analyses and improvements process with P5, D5, C5 and A5.

Each table will summarize the four agents involved in each process by definition the input (Source agent) and output (Destination agent) for each agent and their percepts and actions.

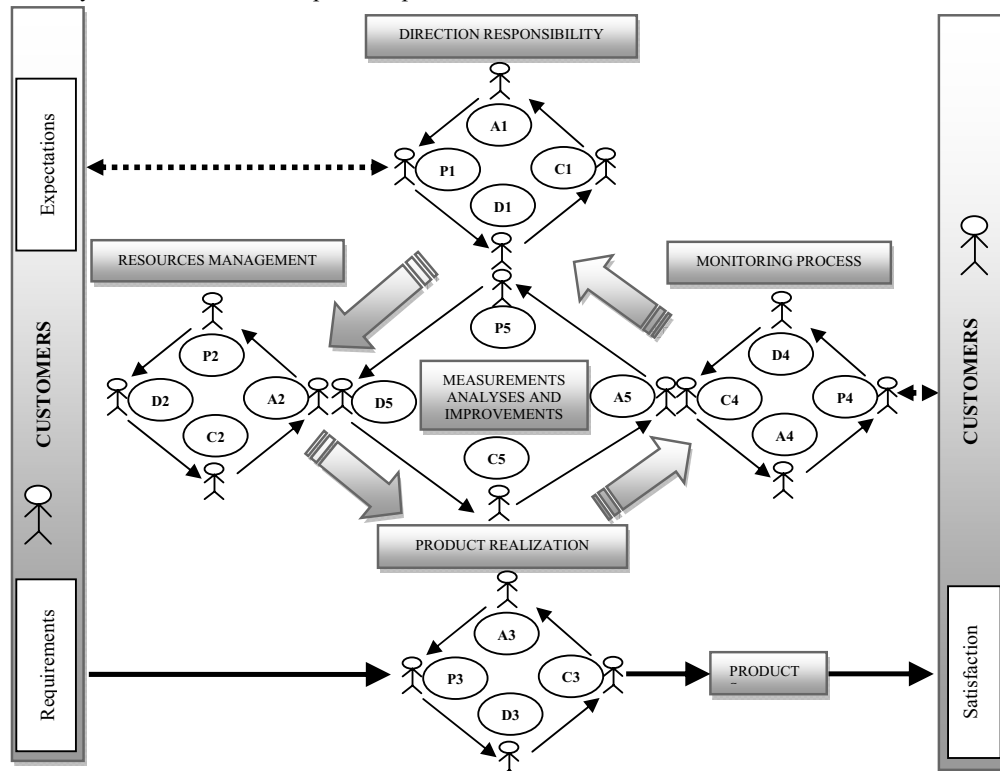


Figure2. QMS design based on the MAS

The P1, D1, C1 and A1 agents work together to ensure the management objectives coherence, the resource requirements determining and the customers expectations. This agent's category remains in relation with the customer agents, the continuous improvement agents and the planning

resource, realization and monitoring agents. Table 1 summarizes the various agents related to direction processes and their interaction with other agents, their actions and perceptions.

TABLE I. APPLICATION OF MAS IN DIRECTION PROCESS

Source Agent	Percepts	Agents	Actions	Destination Agent
		<i>Customer</i>	- Satisfaction level	P4
			- Claims	P3
			Requirements	P1
Customer	Expectations	<i>P1</i>	Objectives synthesis	D1
A1	Improvements requests to planning objectives		- Elimination of objectives	
A5	Change, creation or deletion requests of objectives		- Change of targets - Addition of new objectives - Change of target objectives plans	
P1	Objective	<i>D1</i>	- Ensuring the objectives consistency	C1
			- Assignment of target objectives	P2
			- Allocation of periods target	P3
			- Deployment of objectives for resources process	P4
			- Assignment of performance indicators for resources process	P2
			- Deployment of objectives for realization process	P3
- Assignment of performance indicators for realization process	P4			
			- Deployment of objectives for monitoring process	P4
			- Assignment of performance indicators for monitoring process	P4
			- Performance indicator for each process	P4
			- Objective for each process	P4
			- Estimation of means and resources needs coherent with the objectives	P2
D1	- Objectives consistency - Targets assigned objectives - Targets planned by period	<i>C1</i>	Test for coherence of objectives	A1
C1	Result for coherence of objectives	<i>A1</i>	Requests for improvements of objectives planning	P1

The P2, D2, C2 and A2 agents contribute together to ensure the allocation resource in accordance with the objectives and determining the different schedules related to human and material resources. These agents correlate with

the directions and the continuous improvement agents. Table2 summarizes the various agents related to resources management processes and their interaction with other agents, their actions and perceptions.

TABLE II. APPLICATION OF MAS IN RESOURCES MANAGEMENT PROCESS

D1	- Objectives of the resources process	<i>P2</i>	Allocation of resources in accordance to objectives	D2	
	- Performance Indicators of the resources process				
A5	Estimated resource needs				
A2	Needs to improve human and material resources and increase or delete of resources		- Recruitment planning - Planning to acquire the means - Training planning - Maintenance Planning - Planning for dismissal		
P2	- Allocation of resources in accordance to objectives - Recruitment planning - Planning to acquire the means - Training planning - Maintenance Planning - Planning for dismissal	<i>D2</i>	- Recruitment - Training - Maintenance - Dismissal - Acquirement the means	C2	
D2	- Recruitment realized - Training realized - Maintenance realized - Means acquired - Dismissal effectuated	<i>C2</i>	- Test adequacy of new profiles recruits with the needs - Test training effectiveness - Test maintenance effectiveness - Test of resources adequacy with the needs expressed - Test on the deadline allocation	A2	
C2	Results of resources adequacy and effectiveness	<i>A2</i>	Needs to improve human and material resources and increase or delete of resources	P2	

The P3, D3, C3 and A3 agents cooperate together to provide the various schedules planning related to the product realization. These agents bind customers agents from specification requirements, direction, monitoring and

continuous improvement agents. Table3 summarizes the various agents related to realization processes and their interaction with other agents, their actions and perceptions.

TABLE III. APPLICATION OF MAS IN PRODUCT REALIZATION PROCESS

Customer	Requirements: - Product and its characteristics - Deadline - Cost	<i>P3</i>	- Planning the deadline - Planning the quantities - Planning the inputs - Planning process parameters of realization - Planning quality control	D3
A3	- Requests for time rectification - Requests for quantities rectification - Requests for input rectification - Request for process parameters rectification			
A5	Improvements to be realized on the product and process			
D1	- Deployment of objectives for realization process - Assignment of performance indicators for realization process			
P3	- Planning the deadline - Planning the quantities - Planning the inputs - Planning the process parameters of realization - Planning the quality control	<i>D3</i>	- The inputs acquisition and using - Product realization - Quantities realization - Plans implementation	C3
D4	Planning of customer complaints treatment		Customer complaints treatment	C4
D3	- Product characteristic realized - Quantity realized - Input used - Deadline realized	<i>C3</i>	- Control the deadline - Control the quantities - Control the inputs - Control the process parameters of realization - Control the quality	A3
C3	- Gap deadline - Gap quantities - Gap inputs - Gap process parameters of realization - Gap quality	<i>A3</i>	- Requests for time rectification - Requests for quantities rectification - Requests for input rectification - Request for process parameters rectification	P3

The P4, D4, C4 and A4 agents work together to ensure the audits planning, customer satisfaction surveys, performance indicators measures and quality control. These agents joined the customers agents, the direction, the

realization and the monitoring agents. Table4 summarizes the various agents related to monitoring processes and their interaction with other agents, their actions and perceptions.

TABLE IV. APPLICATION OF MAS IN MONITORING PROCESS

D1	- Deployment of objectives for monitoring process - Assignment of performance indicators for monitoring process - Performance indicator for each process - Objective for each process	<i>P4</i>	- Planning the internal audits - Planning the customer satisfaction surveys - Planning the indicator performance measures - Planning for product quality assessment - Planning for objectives measuring	D4
A4	- Need to change the audit frequency and method - Need to change the frequency and method of indicator performance measurement - Need to change the product frequency and appraisal - Need to strengthen the customer complaints treatment			
Customer	Customer complaints		Planning of customer complaints treatment	
P4	- Planning the internal audits - Planning the customer satisfaction surveys - Planning the indicator performance measures - Planning for product quality assessment Planning of customer complaints treatment	<i>D4</i>	- Audits realization of each process - Realization of customer satisfaction surveys - Indicator performance measurement - Objectives measurement	C4
C3	Result of quality control		Customer complaints treatment	D3
D4	- State of audits realization - State of customer satisfaction surveys realization - State of indicator performance measurement realization - State of quality product control assessments realization	<i>C4</i>	- Control of audits realization relative to the fixed frequency - Control of customer satisfaction surveys realization - Control of indicator performance measurement realization - Control of objective measurement	A4
D3	Result of customer complaints treatment		Assessing the product quality	C4
C4	- Gap of audits realization - Gap of customer satisfaction surveys realization - Gap of the indicator performance measures realization - Gap relative to the customer complaint - Gap objectives measurement	<i>A4</i>	- Need to change the audit frequency and method - Need to change the frequency and method of indicator performance measurement - Need to change the product frequency and appraisal - Need to strengthen the customer complaints treatment	P4

The P5, D5, C5 and A5 agents participate together in planning the evaluation of efficiency process, the product quality, the objectives realization and customer satisfaction. These agents directly adjust the directions and monitoring

agents. Table5 summarizes the various agents related to measurements analyses and improvements processes and their interaction with other agents, their actions and perceptions.

TABLE V. APPLICATION OF MAS IN MEASUREMENTS ANALYSES AND IMPROVEMENTS PROCESS

D4	- Internal audit scores processes measured - Performance indicator scores process measured - Product quality score - Customer satisfaction score	P5	Evaluation planning of the processes effectiveness, the product quality evolution, the objectives realization and customer satisfaction.	D5
P5	Evaluation planned	D5	Appreciation of the processes effectiveness, the product quality evolution, the objectives realization and customer satisfaction.	C5
D5	Evaluation result of the processes effectiveness, the product quality evolution, the objectives realization and customer satisfaction.	C5	- Effectiveness test of improvements previous actions - Realization test of improvement actions - Realization test of assessments provided	A5
C5	- Gap on improvement actions realization - Gap relative to realize evaluation of the processes effectiveness, the product quality evolution, the objectives realization and customer satisfaction.	A5	Changing the methods and frequency of processes, product and objectives evaluation.	P5
			- Decision of further actions for objectives improvement	P1
			Decision improvement resource	P2
			Decision improvement product	P3

IV. CONCLUSION

This paper proposes a new MAS based approach modeling the QMS continual improvement. Our approach covers the whole PDCA scheme. This is visible from the definition of different objectives where we identify processes in order to model the MAS.

Using these objectives and a brief recall of MAS, we design a QMS based on MAS. Indeed, the idea will be consisted in modeling each process identified through ISO 9000 [6]; ISO 9001[7] and ISO 9004[8] standard by the different steps cover the PDCA scheme. It will be also symbolized by four agents for each process. In addition, we will give the role and significance on QMS presenting the input (Source agent), output (Destination agent), their percepts and actions for each agent which intervenes in five processes namely: (1) direction process with P1, D1, C1 and A1 agents, (2) resources management process with P2, D2, C2 and A2 agents, (3) product realization process with P3, D3, C3 and A3 agents, (4) monitoring process with P4, D4, C4 and A4 agents, (5) measurements analyses and improvements process with P5, D5, C5 and A5 agents.

As a final point, the concretization of our approach depends on its enrichment by adequate tools in order to ensure the effectiveness and efficiency. This will be the subject of our future work.

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