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A framework for strategic agility for high quality manufacturing organizations

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Abstract: - Sudden variation becomes a regular incidence in agile quality. To fulfill rapid response to the dynamic market changes, organizations should be proficient at neutralizing the influence that change has upon its performance measures. Previously, companies focused on their competencies by developing extensive variety of business applications for products with quick variations. The beliefs of change found in strategic agility have a crucial mission of constantly surpassing the competition, even as the market is persistently evolving. Maintaining a strategic based, agile-quality organization will have a direct feedback on the business's market share and participation versus other competitors. This paper focuses on how to build a strategic agility framework. The framework was verified and validated through a case study executed at one of the multinational FMCG plants in Egypt. Two agility enablers assisted in the design of the proposed framework; Quick Manufacturing Response Strategies and Collaborative Virtual Enterprise/Partnership Formation. Various product development lead times have been compared to illustrate the competencies of customer and in turn consumer satisfaction on time. The framework will help FMCGs to achieve rapid response to market fluctuations. An agile quality model was also conducted after the positive feedback that resulted from the proposed framework.

Keywords*: Agility, agile quality models, CPM and PERT*

I. INTRODUCTION

"It is not the strongest of the species that survives, nor the most intelligent; it is the one that is most adaptable to change". Whether these words were quoted from Darwin or Megginson, they perfectly reveal the meaning of agility. In todays globalized market environment, the ability to satisfy customer's expectations is essential to portability. What the manufacturing organizations will face in the near future will be a lot less of mass production and much more into flexible, customized and extensively diverse products. [1]

Agile organizations usually deliver flexibility, speed, quality, service and efficiency. Agility enables firms to react consciously and effectively in a synchronized manner to change in its internal environment. Agility refers to the "strategic ability of an enterprise to adopt and accommodate quickly unplanned and sudden changes in market opportunities and pressure". [2] The fluctuations in the market have to be adopted and in response, the workforce of manufacturing organizations have to be proactive for changes in existing production schedule to supply the new product to the market in a short span of time with high competitive pricing. These circumstances can be easily handled by implementing Agile Manufacturing (AM) concepts which mainly focuses towards fulfilling customer needs in shorter time. [3, 4] The main issue in the new era of manufacturing management is the ability of the organization to handle unexpected changes, to endure unprecedented threats in the business environment, and to take advantage of changes as opportunities. The important thing is the ability of a company to be adaptive to changes in the business environment and to adopt proactive ways in approaching market and customer needs. [5] .Modern manufacturing organizations should be able to reconfigure their current manufacturing system to suit the dynamic customers demand. [6]The scope of this research is to introduce a strategic agility framework. To fulfill this objective the research is organized as follows: a literature review is presented in section 2; section 3 describes the proposed framework; the framework is demonstrated and validated in section 4 using a case study; a general agile quality model is introduced in section 5; finally, several remarks in section 5 conclude the paper. Some detailed results are provided in Appendix 1.

II. LITERATURE REVIEW

World-class performance is a common target that needs continuous effort. In the past, manufacturing organizations recognized that mass production and full utilization of plant capacity was the way to make money. This style of manufacturing resulted in rigid plants that are difficult to be reconfigured, in addition to inflated amount of raw materials, work-in-process and finished goods inventories.

Sheridan in the early 1980s, in pursuit of greater flexibility, elimination of excess in inventory, shortened lead-times, and advanced levels of quality in both products and customer service, industry analysts have popularized the terms `world-class manufacturing' and `lean production'.[7]

In 1991 Don-Taylor mentions that a group of industry executives grouped their efforts in a study which culminated in a two-volume report titled `21st Century Manufacturing Enterprise Strategy'. The report describes how US industrial competitiveness might evolve during the following years. As a result, the Agile Manufacturing Enterprise Forum (AMEF), affiliated with the Iacocca Institute at Lehigh University, was formed and the concept of agile manufacturing was introduced. [8]Kidd declared that manufacturing industry is on the edge of a major shift. This shift will drive manufacturers away from mass production and lean manufacturing, into a world of Agile Manufacturing. There is a growing understanding that global superiority in manufacturing can only be achieved through innovation. Agile Manufacturing is mainly a business concept. It aims at combining organization, manpower and technology into an integrated system. Agility will enable the organization to rapidly respond to changes in the market through the organization's ability to use and exploit its resource and knowledge. [9]

According to Richards 1996, an agile enterprise which has the organizational flexibility to implement for each individual project the managerial drivers that are required, will yield the greatest competitive advantage. Sometimes this will take the form of an internal cross-functional team with participation from suppliers and customers. [10]

The conceptual model of agility designed by (Zhang and Sharifi, 2000), has three constituting elements. These are:

(1) "Agility drivers", which are "the changes/pressures from the business environment that necessitate a company to search for new ways of running its business in order to maintain its competitive advantage";.

(2) "Agility capabilities", which are the" essential capabilities that the company needs in order to positively respond to and take advantage of the changes"; and

(3) "Agility providers", those are "the means by which the so-called capabilities could be obtained".

Based on this model, a manufacturing enterprise faces a variety of changes/pressures in its business environment which drives the enterprise to identify "agility capabilities"' that need to be attained or improved in order to take advantage of the changes. This forces the enterprise to search for different ways and tools to obtain/enhance the required capabilities. Due to their different nature, different organizations will experience different sets of changes as well as different levels of pressures resulting from each change. Consequently, different combinations of capabilities will have to be obtained for different organizations. [5]

Yaghoubi and Rahat Dahmardeh (2010) claimed that the best and newest way of survival in today's competitive market is focusing on organizational agility. [11]In the literature reviewed, several authors present case studies and argumentations on which types of systems can be used in relevance to the type of manufacturing environments. Bertrand and Muntslag acknowledge that each type of manufacturing organization requires a different production control system. [12]Sherehiy et al. mention that a lot of publications on agility that are concerned with the specific strategies, techniques, and manufacturing and/or management practices. Only few researches address the conceptualization and development of an integrated view of the agile enterprise concept. Moreover, most agility related studies concentrate on the theoretical descriptions of agility and agility frameworks. Only few of those metrics and frameworks were investigated in practical research. [16] Researchers have also discussed the existence of a strong relationship between agility and organizational performance [13,14]. Agility can contribute to organizational performance in different ways including: quick response to any changes in customer demand, which enables agile organizations to improve customer satisfaction and grasp valuable opportunities in the market by leveraging knowledge regarding the customer needs and requirements. [15] Based on the literature reviewed it was found that the research lacks a comprehensive strategic framework for an agile system with enablers other than those concerning the manufacturing area. Another gap exists in the negligible number of research studies that deals with agility frameworks in fast moving consumers' goods organizations despite its coherency to the frequent and unpredictable changing market besides the existence of fierce competition.

III. THE PROPOSED STRATEGIC AGILITY FRAMEWORK

The problem that the proposed framework is addressing is how organizations can successfully deal with an unpredictable and constantly changing market environment and in the same time assuring the planned level of the output quality, has been a fundamental topic both in industry and academia for a few decades [16]. Various solutions were proposed: networking, virtual corporations, high performing organizations, flexible manufacturing, just-in-time, and lately; agility. This framework was proposed to describe an approach applicable in manufacturing and enterprise management that is necessary to achieve success in a modern dynamically changing market. In this section, a strategic agility framework is introduced to increase the ability of an organization to respond quickly to the changes in the internal and external business environment and to act proactively to the turbulent changes that occur in the market place. Strategic agility is defined as "the set of business initiatives an organization can readily implement"[17]. To start creating a strategic agility framework, it is important to believe that the framework is grounded on multidisciplinary managerial and production

activities. The proposed framework comprises two levels. A first level activities; Discover, Design, Qualify, prepare, and Launch and a second level documentation process grouped in two gates: Project Establishment and Commitment and Launch Plan Agreement and Authorization**.**

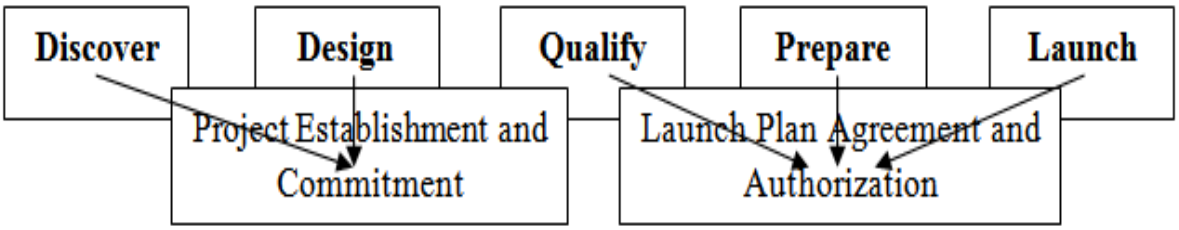

Figure 1: The Proposed DDQPL Framework

3.1 Strategic Agility Activities

DISCOVER promising consumer proposition

This phase relies on the market study of a certain product in order to recognize the acceptance of the customers (retailers) and the consumers (end users).

DESIGN integrated business Proposition

The design stage depends mostly on whether the plant is willing to commit resources to qualify this initiative for the market.

QUALIFY the initiative

It depends mainly on whether the firm has met the launch criteria and ready to proceed with the final launch final preparations in all the markets.

PREPARE for the market launch

Is the firm ready to launch in the individual markets?

Execute market LAUNCH

This stage is responsible for executing market launching of new products and collect feedback to adjust plans. Figure 2 represents the detailed implementation steps for each of the previous activities.

3.2 Strategic Agility Documentation Process

The Project Establishment Document (PE)

The Project Establishment is a summary of a business idea or concept. This formally communicates management's interest in pursuing a specific manufacturing project opportunity and guides a project team to develop an integrated project proposition.

The Project Commitment Document (PC)

Project Commitment formally communicates management's intention to qualify the project for market entry and provide full, multi-functional resources to develop key project elements (i.e. product, package, process, marketing plans, customer plans, sourcing plans) to meet the defined Launch Criteria.

For evaluating the validity of the proposed framework, the framework was executed in one of the international FMCG industries in Egypt. The execution plan and results are introduced in the following sections.

The Role of the PE Document

a) Project Description i.e. it describes the idea and expresses confidence that a sound business proposition (stretch objectives and deliverables) can be developed.

b) Meets consumer needs.

c) Business opportunity/concept supporting data, market/consumer and trade needs, competition, and internal capability and technology.

The Role of the PC Document

a) Defines the Launch Decision Criteria – those critical few criteria that must be met before committing to launch the initiative (i.e. go/no-go criteria)

b) Technical Recommendation is available for those initiatives that require technical feasibility confirmation. Technical recommendation is issued after successful Experimental Orders run at the leadplant.

c) Allocates the resources (people and funds) to complete the development activity (and for long lead-time equipment or supplier advances for initiation stage if necessary).

The Launch Agreement Document (LA)
Launch Agreement communicates a business unit's intention to proceed with launch and expansion.

The Role of the LA Document

a) Defines the Market Readiness Checklist – those items, both commercial and technical, that should be completed prior to regional/local launches.
b) Informs the entire organization:
   i. That the Launch Decision Criteria is met and full-scale preparations for launch are preceded.
   ii. Agreement to all key program elements (e.g. marketing plans, sourcing/production plans, expansion plans, customer objectives' plans)
c) Allocates all resources (people and funds) to complete full expansion of the project.

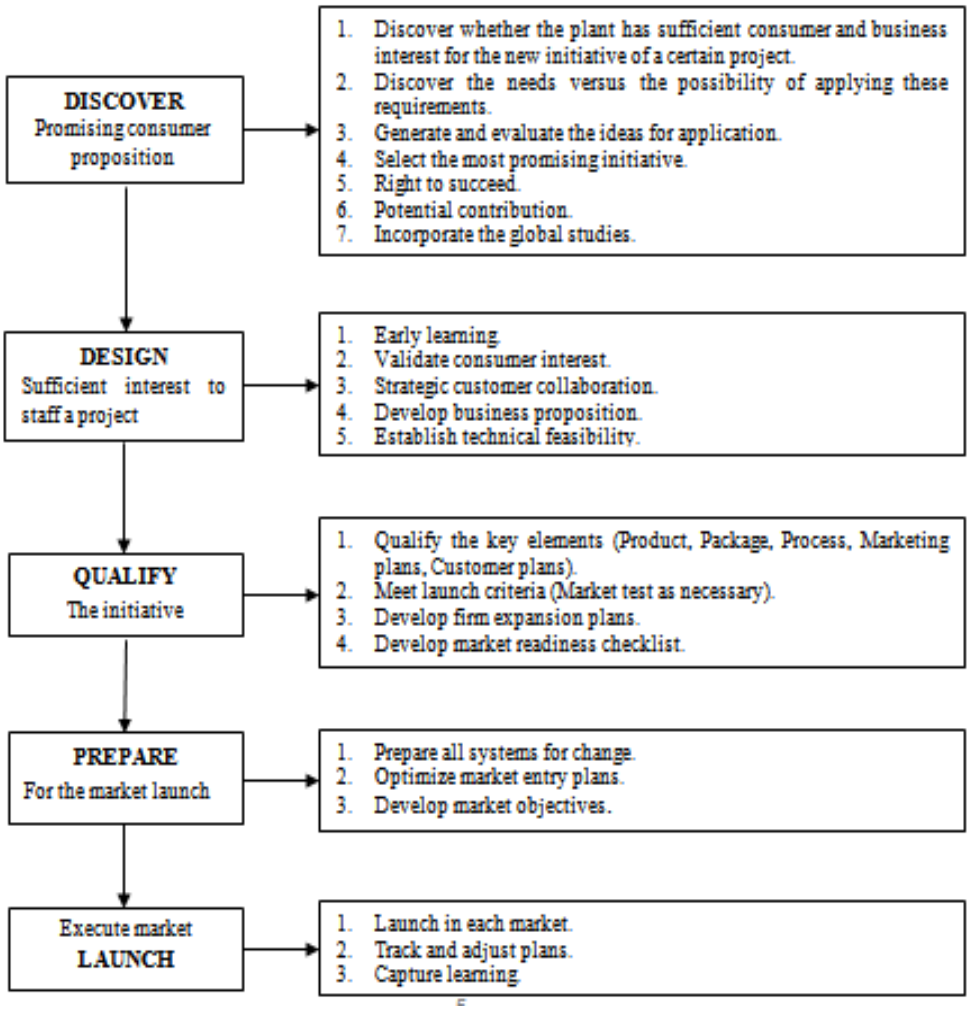

Figure 2: Steps for implementing the DDQPL agility model

IV. Case Study

The execution of the proposed framework was conducted on an initiative within an improvement project. The project was held on a detergent of the X brand. For the sake of applying agile activities; the initiative will include a slight change in its quality concerning the formula and scents. Quality Assurance (QA) tests are held before and after the implementation of the projects. As acknowledged by the company and as per the condition set in the framework; the quality tests and assurance are highly conservative so even if the project was very rapid and feasible but it didn't meet their quality tests, the project will be stopped immediately till further notice from the QA department. During the implementation, the projects didn't encounter any quality issues that may

have stopped them, which indicates that they were implemented smoothly till their production. The difference in agility will be illustrated by comparing the Critical Path Schedules (CPS) of both products. When both schedules are recognized and studied with respect to their time and quality, the model will be standardized and will be used for other brands.

4.1 Objectives

1) Minimize the project lead times by using the proposed framework.
2) Maintain the same quality standards.

4.2 Framework Application and Results

The framework was applied in two main steps; the first step was to conduct the project establishment phase while the second was to launch plan agreement and authorization

4.3 Plan for Executing the Project Establishment Phase

The road map for the project accomplishment was identified by introducing possible initiatives for improvement and deciding upon the most promising initiative.

In the *project establishment* phase it is required to **discover** promising consumer proposition and **design** integrated business proposition. To conduct this phase, it was required to find, collect, and organize the specific detail data that will serve the constructions of what the company desired results and deliverables that they can provide for the chosen brand. Table 1 illustrates a summary for the renovations applied to the brand X initiative.

Table 1 Summary of some desired results for brand X

Design Critical Objectives vs. Competition	**Specific Measures**
Product Performance	Technical Testing
Pricing	Pricing in Market
Artwork & Packaging	Business unit (BU) Assessment
Innovation	Financials

4.4 Agile Execution

Acquiring the various characteristics of agile quality taking place with respect to product renovation and modification. This is done by applying the critical path schedules for the project to compare time consumed using the traditional procedure for project accomplishment versus the proposed framework.

4.5 Plan for Executing the Project Commitment Phase

For approving and tracking the initiatives; there are four software packages used for the purposes of linking, facilitating, and tracking initiatives (the names of the software are kept anonymous as per the confidentiality agreement with the company, but the function of each one is stated)

a) S1: Used for tracking the formula cards and packing material documents.
b) S2: Used for approval of the documents.
c) S3: Intranet to have the initiative master plan uploaded.
d) S4: Enterprise resource planning software

4.6 The Critical Path Schedule (CPS)

The critical path schedule is generated after applying the critical path method technique (CPM). CPM calculates the longest path of planned activities till the project ends, and the earliest and latest times by which each activity can start and finish without making the project longer. This technique determines which activities are "critical" (i.e., on the longest path) and which have "total float" (i.e., can be delayed without making the project longer). In project management, a critical path is the “sequence of project network activities, which add up to the longest overall duration”. This determines the shortest time possible to complete the project. Any delay of an activity on the critical affects the planned project completion date (i.e. there is no float on the critical path). A project can have multiple, parallel critical paths. An additional parallel path through the network with the total durations shorter than the critical path is called a sub-critical or non-critical path.

These results helps managers to prioritize activities for the effective management of project completion, and to shorten the planned critical path of a project by trimming critical path activities, by "fast tracking" (i.e., performing more activities in parallel), and/or by "crashing the critical path" (i.e., shortening the durations of critical path activities by adding resources).

Table 2 represents the critical path schedule (CPS) system that was used to achieve the targeted objectives. Basically this whole process takes in total of 72 days for the completion of all activities.

The CPS system contains various categories of data, for instance duration, resource name, task name, start and finish, predecessors, and the ID. The main category that describes what stage will be held first and for what reasons are the tasks. The tasks name that describes the process that is being conducted starts off with issuing the project commitment, which is the second step after the project establishment, which has the duration of one day. The next step is the confirmation of the lineup that represents the units that will be modified in the project, which also has one-day duration. Followed by a step that requires 15-day duration is the Request & Activate the Finished Product Code (FPC). Conducting the following processes of issuing, approving, and activating the specifications and standards will approximately take 19 days to complete. Once that is complete data input on the enterprise resource planning software to be linked with all the company's related departments starts, this usually taking 16 days to complete. The design of artwork cycle takes 28 days, while the printing of the design will be out sourced and will require 19 days. The Supply Chain Cycle process requires 55 days to complete one full cycle which starts by preparing ordering contracts till the arrival of shipment. Finally the production cycle, which encloses the process from planning to trade, has a cycle that entails 14 days.

4.8 Project Description

In the following generation of brand development stage, the product and its design innovations where reinvented. The key objective behind the development is to provide a product upgrade primarily from a reduction in commodity chemistry. Consequently this had a fluctuating price due to limited supply of the material. The chemical was replaced by another one, which has a stable price in order to fix the consumers value profit in one way or another. In addition a new freshness experience was brought to rebalance the spray-on. Moreover, new materials were introduced as another delighter. The development also will involve a significant artwork change delighting consumers at First Moment of Truth (FMOT).

The initiative allows brand to further build its segment share, hence increasing its category value and customer profitability. An increase in the profit share is expected because of the use of the fixed margins due to the change of the chemistries commodity.

To achieve their targeted objectives, the CPS system was developed referring to the proposed model. Within this process that the CPS system uses both the *Project Establishment and Project Commitment* in coherent document, which is considered to be one conjoint gate. CPS system uses raw data throughout the prevailing gates to contain more effective, efficient, and compressed information that is considered vital to what the CPS system is for and its contents throughout the grouped gates.

As shown in table 2, in the CPS, the main category that describes what stage will be held first and for what reasons are the tasks. The tasks name that describes the process that is being conducted starts off with the first gate that comprises the project establishment and project commitment, which has the duration of one day. The following step is the confirmation of the lineup that represents the Stock Keeping Unit (SKUs) that will be modified in the project, which also has one-day duration. Followed by a step that requires 7-day duration is the Request & Activate the Finished Product Code (FPC). Conducting the following processes of issuing, approving, and activating the specifications and standards will approximately take 12 days to complete. Once that is complete the inputting of data on the enterprise resource planning software to be linked with all the plant's related departments usually taking 13 days to complete. Subsequently, using artwork that has a process cycle for the inner and outer packaging of their products, this activity consumes 19 days. The design of the artwork will be held at the plant's artwork department and the printing of the design will be out sourced and that will take around 19 days. For the Supply Chain Cycle process, which takes around 44 days, shows the steps and process to complete one full cycle from the first ordering contracts till the arrival of shipment. Finally the production cycle, which contains the process from planning to trade, has a cycle that takes 11days.

Basically this whole process takes in total of 56 days for the completion of the proposed framework; this is 16 days less than the regular process.

The proposed framework creates a more effective, and efficient time value, it actually shortens the lead time by one fourth of its predecessor.

This comes down to a simple and effective measure creating a time effective system while holding on to the quality of standers that the projects should have.

4.9 Launch Agreement Phase

The last phase in the framework requires finalizing the quality issues together with the previous studies. Quality issues were definitely assessed according to their specific quality standards and if the project had any minor quality defects, it would have been stopped and suspended till further notice from the QA departments. Snapshots were captured during the revision of the initiatives manager on the quality test results of both initiatives and accordingly the project was capable to proceed for launching.

V. Agile-Quality General Model

As a result of the application of the proposed framework, a general model (Figure 3) was deduced to illustrate what does a business need to be more agile and sustain the same quality level. The model can be implemented at any FMCG company due to rapidness in all development manners. The FMCG industry has to be continuously developing to meet the consumer needs and demand before the competitor breaks through the market share of the plant.

The model defines how to make an agile project and execute an Agile-Quality system to an organization. It has been planned according to the research and case study completed. The model is based on three main routines:

i) Listen to Sense & Respond

This part depends on the company's relationship with the customers, suppliers and consumers and how to gather the information from them. Set the processes and structures to properly define the actions needed then create the right team structures to exert the initiative. Outline the SKUs needed for renovation or extreme make over. Learn from the already developed project pitfalls and focus on how to avoid them. Evaluate the new technologies and strategies available to be able to benefit the most out of these activities. Prepare a budget model and a feasibility study taking in to account the cost needed for renovation.

ii) Emphasize Improvement and Innovation Needed

This section of the model focuses on upgrading the existing organization capabilities before and during implementing the project. The main concern in the whole model is to keep a perfect direct relation with the consumers to be able forecast the upcoming initiatives and get prepared before other competitors. The second main concern is to apply the same quality standards and tests that consumers were used to or even better since projects cannot be implemented within a good period of time but has a dreadful quality. The final quality test is to provide samples to random consumers if possible and wait for their feedback. The samples shall not have the brand name printed on them to make sure the competitor will not recognize the product and develop another product to be released in the market unexpectedly.

iii) Distribute and Coordinate Authority

The ending section is to translate the information grasped from all the past steps to be easily executed by the constituents. Align the tasks with the team members set at the beginning of the project. Set the most suitable software for tracking the initiative development in order to distinguish the defects and pitfalls. Finally, the project will be ready to be carried out safely with an agile-quality system

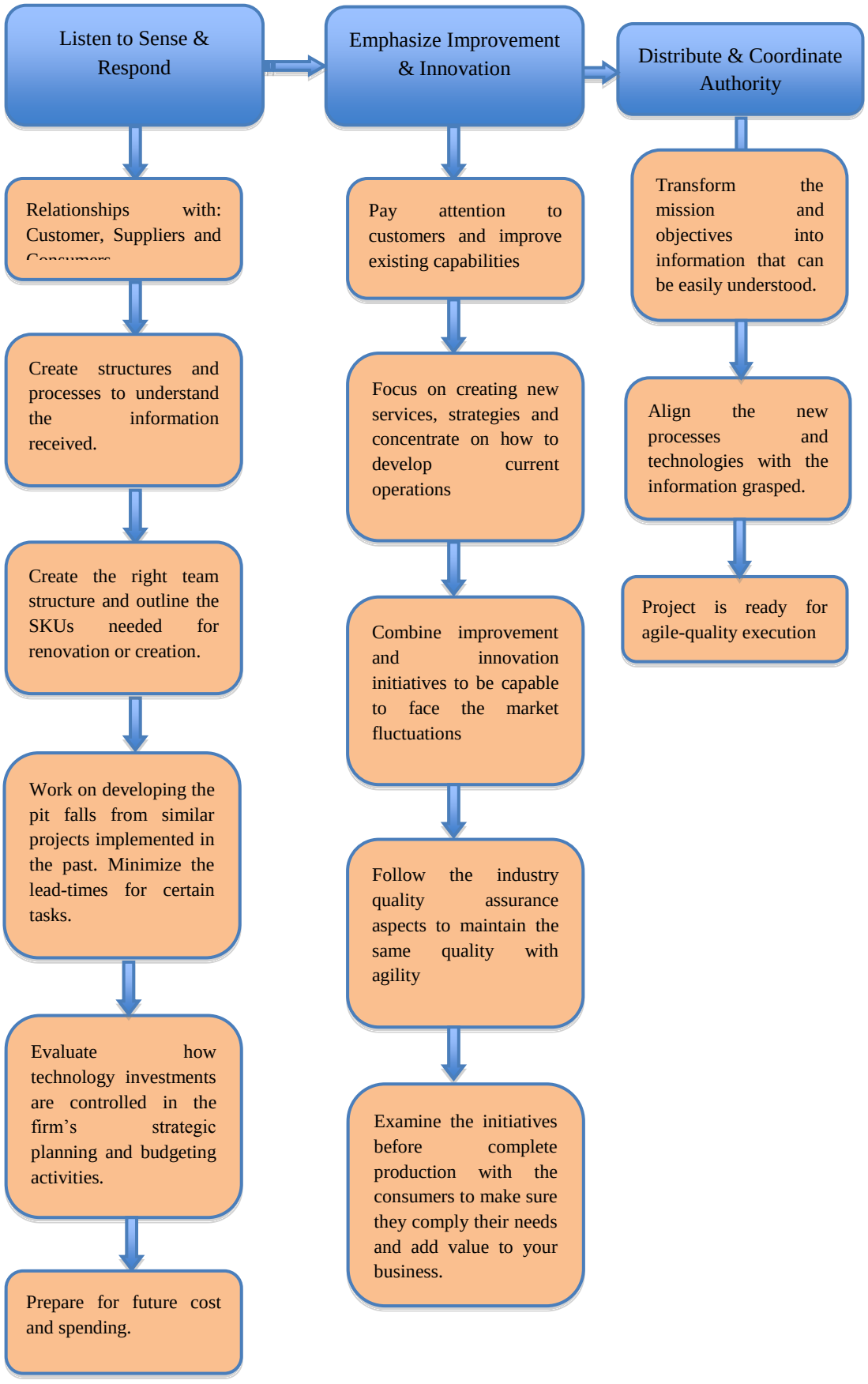

Figure 3: Agile-Quality Model

VI. CONCLUSION

In order to take the full advantage of the agile models, a company has to define its objectives. This paper presented a strategic agility framework to achieve maximum benefits for small to medium size manufacturers based on certain agility enablers.

According to the case study investigated, the proposed framework proved to have better results than the regular planning process. The proposed approach showed better CPS results, as it was 22% faster than the classical approach. As a result of being more flexible and rapid, the plant was able to feed the market with a high quality product quicker than the competitor to meet the customer and the consumer in turn with their needs. In general, the consequence of being more agile and flexible will minimize the scrap as much as possible. This is due to more adaptable processes and documentation when grasping information from the customers to know the demand needed by each of them and if different tastes desired by the consumers have altered, it would be easier to modify in the process with the minimum losses. In turn, the product cost will be lower than it used to and the plant will be capable of building higher profit margins.

After the execution of the framework, a general model was applied to illustrate what does a business need to be more agile and sustaining the same quality. The last but not the least aspect is that the business cannot apply agility by itself; it has to implement it with respect to the quality assurance of the same industry. During the research period, the company has decided started to go agile in other projects by minimizing the lead times for a number of actions and documents needed. The improvement in the rapidness of conducting the studied activities resulted inconsiderable lead time reductions which ranged from 18% to 41%. Finally, it can be concluded that agile-quality is a necessity nowadays to maintain a company, firm, business or corporation market share. Without sustaining in the market, the business will not be able to last for long. Agility is still somehow a recent concept brought to the economy and if the perception was swiftly implemented on the company's hierarchy and organization's procedures with much respect to quality, it will definitely make a great alteration. The shift will become apparent in the quality of work, productivity, cost prices, selling prices, market share, more jobs, better return on investment and finally it will have a positive effect on the economy.

REFERENCES

[1] M. Glenn, 2009, "Organizational agility: How business can survive and thrive in turbulent times," Economist Intelligence Unit Limited, London, U.K.

[2] Saurave Datt et al., 2014, "Alignment of dimensions towards modeling organizational supply chain agility", International journal of services and operations management, vol.17, no.1

[3] A. Gunasekaran, YY Yusuf, 2002, "Agile manufacturing: a taxonomy of strategic and technological imperatives", International Journal of Production Research 40 (6), pp.1357-1385

[4] Vinodh and Aravindraj, 2011; "Agility evaluation using the IF–THEN approach", International Journal of ProductionResearch,Volume50, Issue24,pp.7100-7109 H. Sharifi, Z. Zhang, (2001) "Agile manufacturing in practice - Application of a methodology", International Journal of Operations & Production Management, Vol. 21 Iss: 5/6, pp.772 - 794

[5] Brown, S and Bessant, J, 2003 'The Strategy-Capabilities Link in Mass Customization', International Journal of Operations & Production Management, Vol. 23, No. 7, pp. 707-730

[6] Sheridan, 1993, 'Stepping Beyond Lean Production', Review of agile manufacturing systems, Industry

[7] Don Taylor, 1997, 'Design for global manufacturing and assembly', Agile manufacturing enterprise forum (AMEF), IIE Transactions, p.589

[8] Paul T. Kidd, 1994, "Agile Manufacturing: Forging New Frontiers", ISBN 0-201-63163-6)

[9] Richards, 1996, 'Agile Manufacturing: Beyond Lean', Lean agile or Leagile, Production and Inventory Management Journal, p.63

[10] Yaghoubi, N. M. & Rahat Dahmardeh, M. (2010). Analytical approach to effective factors on organizational agility, Journal of Basic and Applied Scientific Research, 1, 76-87.

[11] Bertnaed and Muntslag, (1993), 'Production Control in Engineer-to-Order firms', Design and reconfiguration of manufacturing systems in agile manufacturing environments, International journal of production economics, p.31-32

[12] Va´zquez-Bustelo et al., 2007 Agility drivers, enablers and outcomes: Empirical test of an integrated agile manufacturing model, International Journal of Operations & Production Management 27(12):1303-1332

[13] Yusuf et al., 2004, A relational study of supply chain agility, competitiveness and business performance in the oil and gas industry

[14] Sambamurthy et al., 2003, Shaping Agility through Digital Options: Reconceptualizing the Role of Information Technology in Contemporary Firms, Management Information System Quarterly, Vol. 27 , Issue 2 (2003)

[15] Sherehiy, B., Karwowski, W., & Layer, J. K., 2007, A review of enterprise agility: Concepts, frameworks, and attributes. International Journal of Industrial Ergonomics, 37, 445-460.

[16] Weill,P., Subramani,M.& Broadbent, M., (2002), Building IT infrastructure for Strategic Agility, MIT Sloan management Review, Fall 2002.

Appendix 1

Table 1: The critical path schedule (CPS) system before applying the proposed framework

ID		Task Name	Resource Names	% Work Complete	Duration	Start	Finish	Predecessors
1		**Bonux WCH Oct 06**		**93%**	**72 days**	**Tue 6/27/06**	**Wed 10/4/06**	
2	✓	Issue Project Commitment	GBU	100%	1 day	Tue 6/27/06	Tue 6/27/06	
3	✓	Confirm lineup	Plant	100%	1 day	Wed 6/28/06	Wed 6/28/06	2
4	✓	**Request & Activate FPC**		**100%**	**15 days**	**Thu 6/29/06**	**Wed 7/19/06**	
10		**Issue, Approve & Activate Specs & Std's**		**0%**	**19 days**	**Wed 7/5/06**	**Mon 7/31/06**	
20	✓	**SAP Cycle**		**100%**	**16 days**	**Sun 7/23/06**	**Sun 8/13/06**	
32	✓	**Artwork Cycle**		**100%**	**28 days**	**Thu 6/29/06**	**Mon 8/7/06**	
33	✓	MEA Design	GBU Marketi	100%	2 wks	Thu 6/29/06	Wed 7/12/06	3
34	✓	Design	Marketing	100%	3 days	Thu 7/13/06	Mon 7/17/06	33
35	✓	Final artwork	Marketing	100%	2 days	Wed 7/26/06	Thu 7/27/06	34,17
36	✓	Color separation	Marketing	100%	3 days	Sun 7/30/06	Tue 8/1/06	35
37	✓	Plates creation	Marketing	100%	1 day	Wed 8/2/06	Wed 8/2/06	36
38	✓	Plates at printer	Marketing	100%	3 days	Thu 8/3/06	Mon 8/7/06	37
39	✓	**Outercases Cycle**		**100%**	**19 days**	**Thu 6/29/06**	**Tue 7/25/06**	
40	✓	Outercases Design	CS	100%	1 wk	Thu 6/29/06	Tue 7/25/06	3,17FF
41	✓	CDs sent to plant	CS	100%	4 days	Thu 7/6/06	Tue 7/11/06	40
42	✓	Plant Disaster check	Techpack	100%	2 days	Wed 7/12/06	Thu 7/13/06	41
43	✓	CDs at printer	Techpack	100%	3 days	Sun 7/16/06	Tue 7/18/06	42
44		**Supply chain cycle**		**100%**	**55 days**	**Sun 7/2/06**	**Thu 9/14/06**	
45	✓	Issue LA	MDO	100%	18 days	Sun 7/2/06	Tue 7/25/06	2
46	✓	Updated demand in WDRP	CS	100%	1 day	Mon 8/14/06	Mon 8/14/06	45,31,38
47	✓	Prepare RFContracts	Initiative	100%	1 day	Wed 8/9/06	Wed 8/9/06	27
48	✓	Setup contracts	VB	100%	1 day	Thu 8/10/06	Thu 8/10/06	47
49		Place Primary packaging orders	Planners	0%	0 days	Thu 8/10/06	Thu 8/10/06	45,48,38
50		Place secondry packaging orders	Planners	0%	0 days	Thu 8/10/06	Thu 8/10/06	43,48,45
51	✓	Primary packaging arrival	Planners	100%	5 wks	Sun 8/13/06	Thu 9/14/06	49
52	✓	secondary packaging arrival	Planners	100%	4 wks	Sun 8/13/06	Thu 9/7/06	50
53	✓	**Production Cycle**		**100%**	**14 days**	**Sun 9/17/06**	**Wed 10/4/06**	
54	✓	Building opening stocks	Plant	100%	10 days	Sun 9/17/06	Thu 9/28/06	51,52
55	✓	Planning for shipment	CS	100%	1 day	Sun 10/1/06	Sun 10/1/06	54
56	✓	SOS to Trade	CS	100%	3 days	Mon 10/2/06	Wed 10/4/06	55

Table 2: The CPS system after applying the proposed framework

ID	Task Name	Resource Names	% Work Complete	Duration	Start	Finish	Predecessors
1	**Bonux Casio W2 Egypy**		1%	56 days	Sun 11/16/08	Sun 2/1/09	
2	Issue PE/PC	GBU	100%	1 day	Sun 11/16/08	Sun 11/16/08	
3	Confirm lineup	Plant	0%	0 days	Sun 11/16/08	Sun 11/16/08	2
4	**Request & Activate FPC**		0%	7 days	Sun 11/16/08	Tue 11/25/08	
10	**Issue, Approve & Activate Specs & Std's**		0%	12 days	Mon 11/17/08	Tue 12/2/08	
20	**SAP Cycle**		0%	13 days	Thu 11/27/08	Mon 12/15/08	
32	**Artwork Cycle**		0%	19 days	Mon 11/17/08	Thu 12/11/08	
33	MEA Design	GBU Marketi	0%	1 wk	Mon 11/17/08	Sun 11/23/08	3
34	Design	Marketing	0%	3 days	Mon 11/24/08	Wed 11/26/08	33
35	Final artwork	Marketing	0%	2 days	Tue 12/2/08	Wed 12/3/08	34,17
36	Color separation	Marketing	0%	3 days	Thu 12/4/08	Mon 12/8/08	35
37	Plates creation	Marketing	0%	1 day	Tue 12/9/08	Tue 12/9/08	36
38	Plates at printer	Marketing	0%	2 days	Wed 12/10/08	Thu 12/11/08	37
39	**Outercases Cycle**		0%	9 days	Mon 12/1/08	Thu 12/11/08	
40	Outercases Design	CS	0%	1 day	Mon 12/1/08	Mon 12/1/08	3,17FF
41	CDs sent to plant	CS	0%	4 days	Tue 12/2/08	Sun 12/7/08	40
42	Plant Disaster check	Techpack	0%	2 days	Mon 12/8/08	Tue 12/9/08	41
43	CDs at printer	Techpack	0%	2 days	Wed 12/10/08	Thu 12/11/08	42
44	**Supply chain cycle**		0%	44 days	Mon 11/17/08	Thu 1/15/09	
45	Issue LPA/LA	MDO	0%	18 days	Mon 11/17/08	Wed 12/10/08	2
46	Updated demand in WDRP	CS	0%	1 day	Tue 12/16/08	Tue 12/16/08	45,31,38
47	Prepare RFContracts	Initiative	0%	0.5 days	Thu 12/11/08	Thu 12/11/08	27
48	Setup contracts	VB	0%	0.5 days	Thu 12/11/08	Thu 12/11/08	47
49	Place Primary packaging orders	Planners	0%	0 days	Thu 12/11/08	Thu 12/11/08	45,48,38
50	Place secondry packaging orders	Planners	0%	0 days	Thu 12/11/08	Thu 12/11/08	43,48,45
51	Primary packaging arrival	Planners	0%	5 wks	Sun 12/14/08	Thu 1/15/09	49
52	secondary packaging arrival	Planners	0%	4 wks	Sun 12/14/08	Thu 1/8/09	50
53	**Production Cycle**		0%	11 days	Sun 1/18/09	Sun 2/1/09	
54	Building opening stocks	Plant	0%	8 days	Sun 1/18/09	Tue 1/27/09	51,52
55	Planning for shipment	CS	0%	1 day	Wed 1/28/09	Wed 1/28/09	54
56	SOS to Trade	CS	0%	2 days	Thu 1/29/09	Sun 2/1/09	55