ICT Platform Design for SME Collaboration

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Abstract. Collaboration is frequently used both in literature and in practice as a sustainability and survival strategy for SMEs. In this study, we propose an ICT Platform to support SME Collaboration in discrete complex manufacturing industries. The proposed ICT Platform is defined by a conceptual platform and functional and process flows. Initially an SME network vision is set with three dimensions; sustainability, growth, and survival. And then, a Balanced Scorecard application has been performed to translate the SME network strategy to operational level ICT initiatives. Finally based on the guidance received from the literature and the established ICT initiatives, a set of ICT tools were created for the business model. These tools include a conceptual framework and the characterization of functional, informational and process flows to support the business model.

Keywords: SME Collaboration, ICT Platform, Process Flow

1 Introduction

Small and Medium Enterprises (SMEs) represent a high percentage of the world's economic power. Forming collaborative networks is frequently addressed as a survival and sustainability tool for SMEs in the global markets [1], [2]. By joining their resources and competencies through networked manufacturing, SMEs can reach a larger dimension, access global markets, share risks, and nurture innovation through collaborative product development [3]–[5].

The need to align business strategy with ICT strategy and development was highlighted frequently in the literature [6], [7]. While ICT development starts from the operational level and builds through tactical and strategical levels, strategy setting starts from the strategic level and is translated to tactical and operational levels [8]. In this context, in order to develop efficient operational level ICT tools, it is therefore required to clearly translate strategic objectives into implementable operational initiatives.

In an extensive literature review, we have not come across any studies, which relate the company's business strategy with operational level ICT initiatives. Some of the reviewed papers work on the integration of the operational level, with no evidence

of strategy concerns or they rather follow an incremental approach, where they initially develop business architecture and then create more focused decision support tools.

Our main observation is that, while the theoretical literature continuously repeats the need for strategic and operational alignment and for business strategy and ICT strategy alignment, in practice and in general, applications are very limited and deceiving. On the other hand, the literature on Collaborative Networks mainly covers research to guide real life applications and focuses on developing practical tools to support inter organizational collaboration. Organizations are looking for methodologies to support a high level of integration and since collaboration brings many immediate benefits to all partners, the development of a long-term vision and of a strategy has been ignored.

In this work, we have presented the methodology that supports the design of ICT platform to support a Collaborative network. The methodology consists of three main steps: Initially the SME network vision was set as sustainability, survival, and growth. Later by implementing a balanced scorecard approach, the vision was translated into ICT initiatives, which create the base for a conceptual framework. Finally, the functional and process flows of the ICT Platform are designed and presented.

2 The Proposed Business Model

The proposed collaborative business model, designed to support SMEs functioning in discrete complex manufacturing industries, is composed of two organizational layers: SME Network and Dynamic Manufacturing Network (DMN).

While an SME network is the first organizational layer (strategic network), the DMN constitutes the second layer (operational net-work). SME networks are strategic partnerships of autonomous SMEs that collaborate to reach joint goals and they precede DMN formation. SME Networks provide long-term integration between network members, support their healthy operation, maintain trust and fairness between members, and develop strategies to manage the operational level decisions. The DMN, as the second layer of the business model, is defined as a temporary or long term collaborative network, that counts on joint manufacturing efforts of geographically dispersed SMEs and/or OEMs [9], [10]. DMNs are formed to satisfy specific business opportunities (either one time or repetitive) and dissolve once the orders are delivered.

Figure 1 presents the proposed business model, which functions as an intermediary between the customer and the manufacturer sides of the industry. The customer side is integrated through an e-commerce module, and a sell side marketplace is developed for customer communication.

On the manufacturing side, DMN formation and operational planning require integrated business processes and an automated, collaborative ICT platform. This collaborative platform needs to be built in order to assist the DMN life cycle, to support SME network decision making, and to monitor order processing. The collaborative platform can be used simultaneously by several DMNs that are designed to fulfill different business opportunities.

The proposed business model requires automated processes to assist the DMN life cycle, and the business functions to support SME net-work decisions. A DMN works at the operational level and requires detailed focused decision support tools to enable and optimize its operations. In this context, an ICT platform should both support the back end and the front end of the whole supply chain, should facilitate interoperability among autonomous members, should enable communication flows within the net-work, and should assist business processes through the DMN life cycle [11].

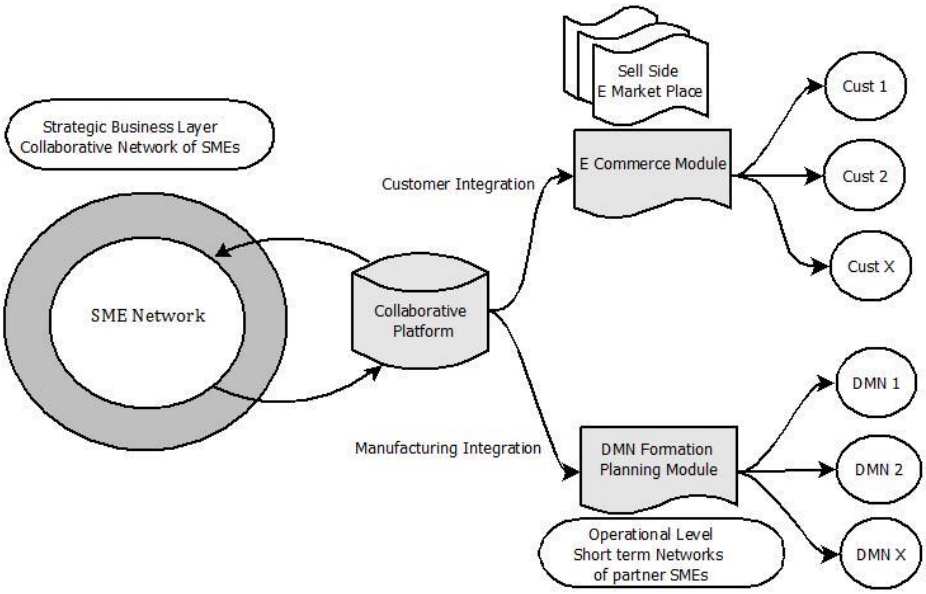

Fig. 1. SME Network and DMN Business Model

Moreover, the development of ICT tools is necessary to decrease decision making time and increase operational efficiency. ERP applications provide control over shop floor operations but they do not provide a means to link the autonomous network members.

3 From Strategy to ICT Initiatives: A Balanced Scorecard Application

Several researchers have discussed the need for alignment of the business strategy and the ICT strategy. It is claimed that identifying a sound business strategy is the key for business process agility [6]. To successfully support business processes, the ICT strategy also needs to be aligned with the business strategy. An automated network needs to initially define its business requirements which will lead to a business architecture to be further supported by an ICT infrastructure [7]. Business model development and

goal setting are clearly the basis for developing a correct information technology infrastructure.

While strategy development needs to start at the strategic level, by SME network goal setting and strategy setting, process integration needs to start at the operational level by developing a set of automated collaborative processes. In terms of process integration, as we go from bottom to top, the level of integration decreases and tools move from detailed mathematical decision support systems to conceptual frameworks or reference models. On the other hand, in terms of strategy setting, decision makers need to first decide the strategy of the SME network and later, develop ICT tools at the operational level, by translating that strategy to operational goals. In order to create successful collaborative networks, the business strategy should be integrated into the development of ICT tools and decision-making methodologies.

In order to align ICT design with business strategy, we defined the SME Network vision, and translated it into ICT strategies. The SME network vision is initially grounded on three components: sustainability, survival, and growth. While *survival* is the act of standing against economic crisis and other disturbances in the system, *sustainability* stands for withstanding internal organizational challenges. *Growth*, on the other hand, stands for the expansion of the SME network along time. This vision is then translated into operational level ICT initiatives through the Balanced Scorecard methodology.

The Balanced Scorecard (BS) framework has been widely used as a strategic management tool. Since it was proposed in the 1990s, it is has been used to measure and manage four aspects of organizational performance: Financial, Customers, Internal Business Processes, and Learning and Growth.

BS allows decision makers to extend their myopic, only financially focused-perspective, to other decision dimensions and stakeholders. In BS development, all four perspectives are guided through four major steps:

1. objectives clarify the company vision and translate it into a strategy;
2. measures provide quantitative indicators for each objective, and allow decision makers to link objectives with results;
3. targets allow decision makers to set specific goals, through long term or short term quantitative or qualitative goals;
4. initiatives recommend some actions that can be taken in order to reach identified targets for each objective

We have adapted the BS methodology by focusing on our three different vision components: sustainability; growth; and survival. We have connected each vision to one or more balanced scorecard perspective as follows: Sustainability to internal business processes perspective; growth to customers and financial perspectives; and survival to learning and improvement perspectives. Due to page limitations only sustainability balance scorecard will be presented in this section.

Table 1 presents the developed Sustainability Balanced Scorecard. In order to maintain the group cohesion and harmony required to sustain the collaborative network, the following sustainability objectives were developed: supporting conflict resolution between members; establishing high trust value, establishing high reliabil-

ity value, establishing high fairness value and providing a membership management function.

Table 1. Sustainability Balanced Scorecard

SUSTAINABILITY					
	OBJECTIVES	**MEASURES**	**TARGETS**	**IT INITIATIVES**	**ICT TOOLS**
Internal Business Processes Perspective	Support Conflict Resolution between members	Visibility of Operations	none	Provide reporting for SME network decisions	**Reporting**
		Develop Initial aggrements	none	Prevent possible future conflicts by developing initial aggrements	**Membership Management**
	Establish High Trust Value within network	Trust of partners to the SME Network	max	Set and track trust measures between partners and the SME network	**Trust Management**
		Trust between partners	max	Set and track trust measures between partners	**Trust Management**
	Establish High Reliability Value	Reliability of logistics	max	Set and track reliability measures for logistics operations	**Reliability Management**
		Reliability of raw material	max	Set and track reliability measures for raw material received from suppliers	**Reliability Management**
		Reliability of the ICT Platform	none	Provide security mechanisms for the ICT Platform	**ICT Platfrom security**
		Reliability of data	max	Set and track reliability measures for the data received from partners	**Reliability Management**
	Establish High Fairness Value	Fairness of the SME Network	max	Set and track fairness measures for SME network joint functions	**Fairness Management**
		Fairness in demand sharing	none	Develop fair demand sharing mechanisms	**Demand Sharing**
		Fairness in revenue sharing	none	Develop fair revenue sharing mechanisms	**Revenue Sharing**
		Fairness in cost sharing	none	Develop fair cost sharing mechanisms	**Cost Sharing**
	Provide Membership Management	Member Profiling	none	Develop member performance Module	**Performance Management**
		Membership Management	none	Develop member association and dissociation Module	**Association Dissociation and Decision Making**

These objectives have guided us to identify the following ICT initiatives: set and track measures for each group cohesion component; provide reporting for network decisions and actions; develop pre-membership agreements; develop fair sharing mechanisms; develop member performance module; and develop a member association/dissociation DSS.

The ICT initiatives will later be classified in a conceptual framework, which will support the design of the ICT platform. A conceptual framework draws the outline for business models by defining a number of sub-models, collections of templates, procedures, methods, rules and tools.

The outputs of the Balanced Scorecards (from the previous section) have been grouped in order to create the conceptual framework. The developed framework covers three main functions: SME network support functions, e-commerce functions and DMN support functions. Due to page limitations, conceptual framework is only briefly mentioned.

4 ICT Tools

Based on the ICT initiatives, conceptual framework and literature review findings, we have developed a set of ICT tools to assist the business model. We propose here an organization of the functional flows as follows: Order Promising; DMN Life Cycle Management; Customer Relations; Membership Management; and Group Cohesion Management. Fig.2. shows the functional flows of the ICT platform and Fig. 3. presents the process flows of the system.

The overall process of operational planning in an SME network starts with a customer interaction through the e-marketplace. The production system operates under an Available to Process (ATP) strategy. Once the e-marketplace receives a new customer order, the order-promising module will be triggered, in order to check order feasibility both in terms of available capacity and required competencies. Online partner and order information will be extracted via the DMN Collaborative Platform. After the Order Acceptance submodule confirms acceptance of an order, this order will be combined with other orders for classification and prioritization.

The Order Prioritization submodule will compute order priorities, via a multi-criteria decision making tool. Order priorities will be utilized in the DMN Creation submodule, so that orders that are more valuable are processed first. On the other hand, the Order Classification submodule will compute order classes through data mining and data science approaches. Order classes can be used in strategy and promotion development for different order classes. These modules will be fed with information on order characteristics (due date, volume, processing time, etc.) and on customer characteristics.

In the DMN Creation submodule of DMN Life Cycle Management module, a multi-objective mathematical model is employed to decide DMN configuration and to compute the production and transportation lot sizes. The model will use several objectives such as cost, flexibility, partner reliability, order priority or operational risk and will take into account partner capacities, capabilities, order priorities, and costs.

The order priorities generated by the Order Prioritization submodule and customer priorities calculated by the Customer Prioritization submodule, will also be considered in the DMN formation process.

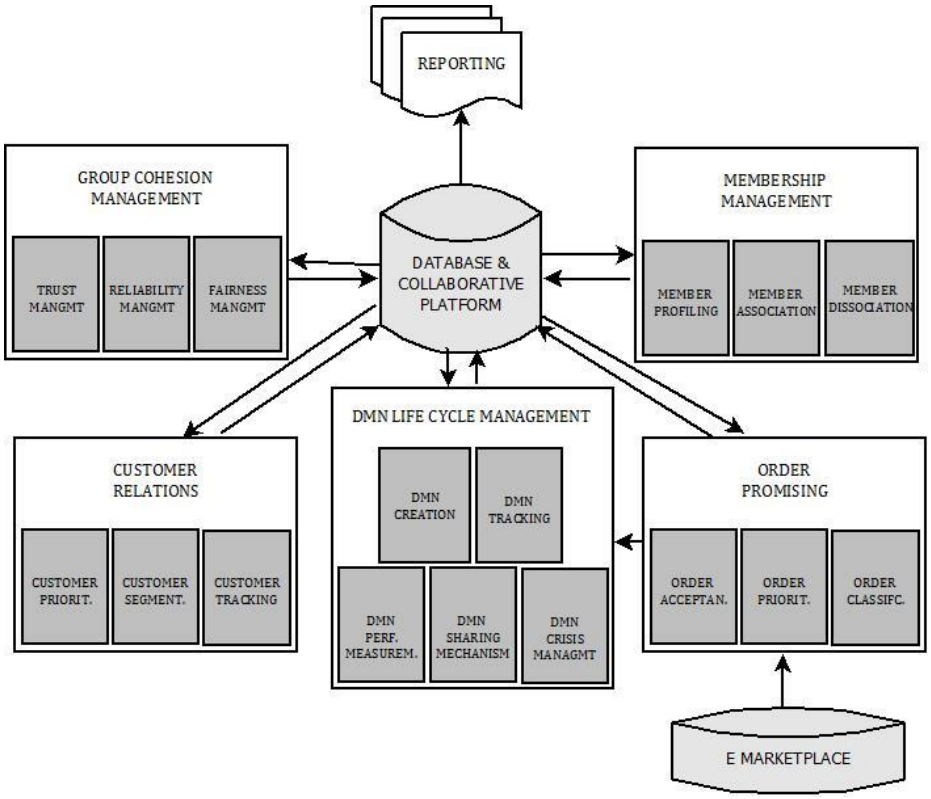

Fig. 2. Functional Flows

Since DMNs typically serve to a group of distinct customers, it is a good strategy to take into account customer characteristics during DMN formation. In order to enable the formation of customer and order driven DMNs, the Customer Relations module will provide its input on customer priorities and customer segments. At this stage, the DMN Risk Management submodule of DMN Crisis Management uses mathematical tools to predict operational risks related to DMN processes, and integrates the results to the DMN creation process. Once the DMN configuration and operational plans are set, job orders will electronically be transmitted to selected partners. In order to maintain visibility within the network, all the partners of the SME network will receive a report stating the DMN configuration and plans.

In the DMN tracking phase, if a deviation from the initial plan is detected, the DMN Event Management submodule of the DMN Crisis Management submodule will trigger an action. It may either reschedule production among current DMN partners, or include new partners to the DMN in order to assign them the failed operations. Once the operations are performed, the DMN Performance Measurement submodule assesses the performance of each partner. Moreover, DMN partners will also evaluate their trust towards the SME network and the other partners. DMN performance assessments will be stored in the Collaborative Platform database for future

tracking purposes. While failing in one DMN is probably acceptable for a partner, failing frequently is an important problem that requires further attention. Finally, the DMN Sharing module will employ decision-making mechanisms to partition joint costs and benefits among partners, by taking into account their performances within the DMN.

The Customer Relations module analyzes customer data, and consists of three distinct submodules: Customer Prioritization; Customer Segmentation; and Customer Tracking. Initially, the Customer Prioritization submodule feeds the DMN Creation submodule with values for customer priorities. The Customer Segmentation submodule then creates customer segments, again based on past customer information, thus providing information that can be utilized to develop strategies and promotions for similar customers. On the other hand, the Customer Tracking submodule calculates customer preference patterns, in order to support product development.

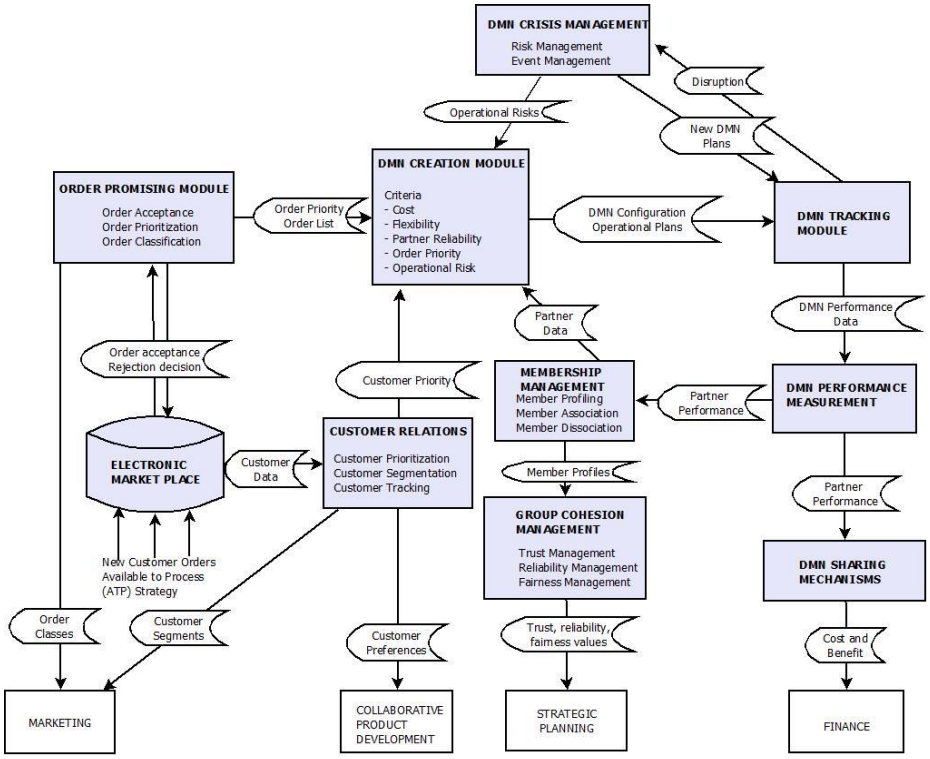

Fig. 3. Process Flows

5 Conclusions

In this work, we have designed a set of ICT tools to support a business model based on two organizational layers: SME Networks and Dynamic Manufacturing Networks. Initially, we have identified three components of the SME network vision: Sustainability; Survival; and Growth. Later, we have implemented a Balanced Scorecard approach to translate the SME network vision into operational level ICT initiatives. These ICT initiatives, along with comprehensive literature review findings, provided a basis to design an ICT Platform.

Two layers of ICT Tools were designed for the business model: a conceptual framework to support SME Network functions; and functional and process flows for the business model. These instruments are expected to adequately guide the development of focused decision support tools.

Nowadays, Collaborative Networks are highly dependent on ICT platforms and automated processes. Developing such integrated tools by following a well-defined methodology will have several benefits. Since partners get involved in these collaborative networks mostly for long-term advantages, developing a long-term vision and aligning strategy with action improves the credibility of the Collaborative Network in the partners' perspective. Moreover, it broadens the short term oriented, financial benefits-focused perspective into longer-term objectives, such as growth, sustainability and survival. Developing a clear vision and implementing it into operations increases the resilience of organizations in today's turbulent markets. Moreover, automated processes working with real time data significantly shorten the decision making time and make the operational execution much easier.

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