An Information System Framework and Prototype for Collaborative and Standardized Chinese Liquor Production

Completed Research Paper

Can Yang
Business School,
Sichuan University, PR China
yangcan1991@gmail.com

E.W.T. Ngai
Department of Management and Marketing
The Hong Kong Polytechnic University
eric.ngai@polyu.edu.hk

Z.X. Guo *
Business School,
Sichuan University, PR China
zx.guo@alumni.polyu.edu.hk
* Corresponding Author

Li Luo
Business School,
Sichuan University, PR China
luolicc@scu.edu.cn

Abstract

There is a pressing need for Chinese liquor producers to use information systems in managing production process and improving production efficiency for meeting fiercely increasing market competition. Unlike liquor production in other countries, Chinese liquor production replies on experience and manual operations greatly, which has very low-level automation and informatization. This paper takes a famous Chinese liquor producer as the target case company, introduces typical information systems used in Chinese liquor production, explores the motivations to implement information systems, and examines the benefits, the problems encountered as well as the key success factors in implementation and applications of information systems in Chinese liquor production industry.

Keywords

Baijiu, Liquor production, Informatization, Production management system.

Introduction

Research background and questions

The history of liquor in China spans thousands of years. Chinese liquor (baijiu in Chinese Pinyin) is closely linked to people's daily lives and plays an important role in China's economy. Liquor production in China is characterized by low centralization, fierce market competition, low-level automation, informatization and standardization. Currently, Chinese liquor producers have a pressing need to speed up their transformation and upgrading by improving their production standardization and production efficiency.

Liquor production is a key part of the liquor supply chain in China. Compared with other manufacturing industries, Chinese liquor production has some distinct features, such as the low degree of informatization and production standardization, the preservation of traditional liquor-making techniques, and the high dependence on manual operations. Maintaining the quality stabilization of liquor products greatly troubles Chinese liquor producers because technical standards of some key technical operations have not been well-quantified and the production of these operations depends largely on workers' experience. Moreover, a timely and effective cross-departmental collaboration as well as accurate and timely production analysis and decisions are difficult to achieve because of incomplete production data collected and poor information visibility. The implementation of information systems can bring

significant benefits, such as more efficient operation, higher information visibility, shorter information sharing time, and better consistency for improved decision making (Ngai et al. 2012; Laudon et al. 2012).

This paper proposes an information system framework for collaborative and standardized liquor production in China. The paper specifically addresses the following questions: (1) How is an information system framework developed to meet the requirements of collaboration and standardization in Chinese liquor production? (2) Under this framework, what is the state-of-the-art implementation and applications of information systems in Chinese liquor production? (3) What are the challenges and benefits of implementing the system prototype?

Literature review

A large amount of research has been devoted to the implementation of information systems (Bansler et al. 2010; Dymoke-Bradshaw et al. 2011; Olson et al. 2012; Zhang et al. 2005), most of which were conducted based on case study approaches. It is well known that case study is one of the most popular qualitative approaches in the studies of information systems (Choi et al., 2013). Zhang et al. (2005) examined the enterprise resources planning (ERP) system implementation in the manufacturing companies of China and proposed a system implementation framework to identify the critical success factors. Bansler and Havn (2010) examined the issues and challenges involved in designing and organizing pilot implementations of health information systems. Dymoke-Bradshaw and Brown (2011) investigated the information system implementation in the healthcare industry and proposed a reflective framework for successful system implementation in healthcare. Some researchers have pointed out that the system implementation in China is different from that of other countries because of China's distinct business practices, such as guanxi (Avison et al. 2007). Xue et al. (2005) examined some possible reasons why leading international ERP solution vendors could not dominate the ERP system market in China. However, research on the implementation and applications of information systems in Chinese liquor production has not been reported so far.

This paper will introduce the production processes involved in Chinese liquor production firstly. An information system framework is then proposed for production collaboration and standardization. Taking a famous Chinese liquor producer as the case company, we then introduce typical information systems implemented under this framework and examine the benefits and problems encountered, as well as the key success factors, in the implementation and application of these systems.

To collect the data used in case study, we conducted a series of face-to-face semi-structured interviews with staff members from production and information departments of a case company. Some documents were also used, which included the user manuals and technical documents of information systems used in this Group and publicly available news and statistics from the company's website and annual reports.

Liquor production processes

With the development of the Chinese liquor industry, various innovations of liquor-making techniques, especially the innovation in liquor flavors, have been created in recent years. The number of liquor flavors has increased from 4 to 12 since the 1970s. Different production processes are involved in making different liquors.

This research was conducted based on the production processes of the Chinese liquor with the most popular flavor (strong aromatic). Production of this type of liquor involves four main production processes, namely, preparation of raw and auxiliary materials, base liquor production, blending, and packaging. These production processes involve more than 30 operations, which can be simplified from the perspective of production management (Figure 1). The four main production processes are described as follows:

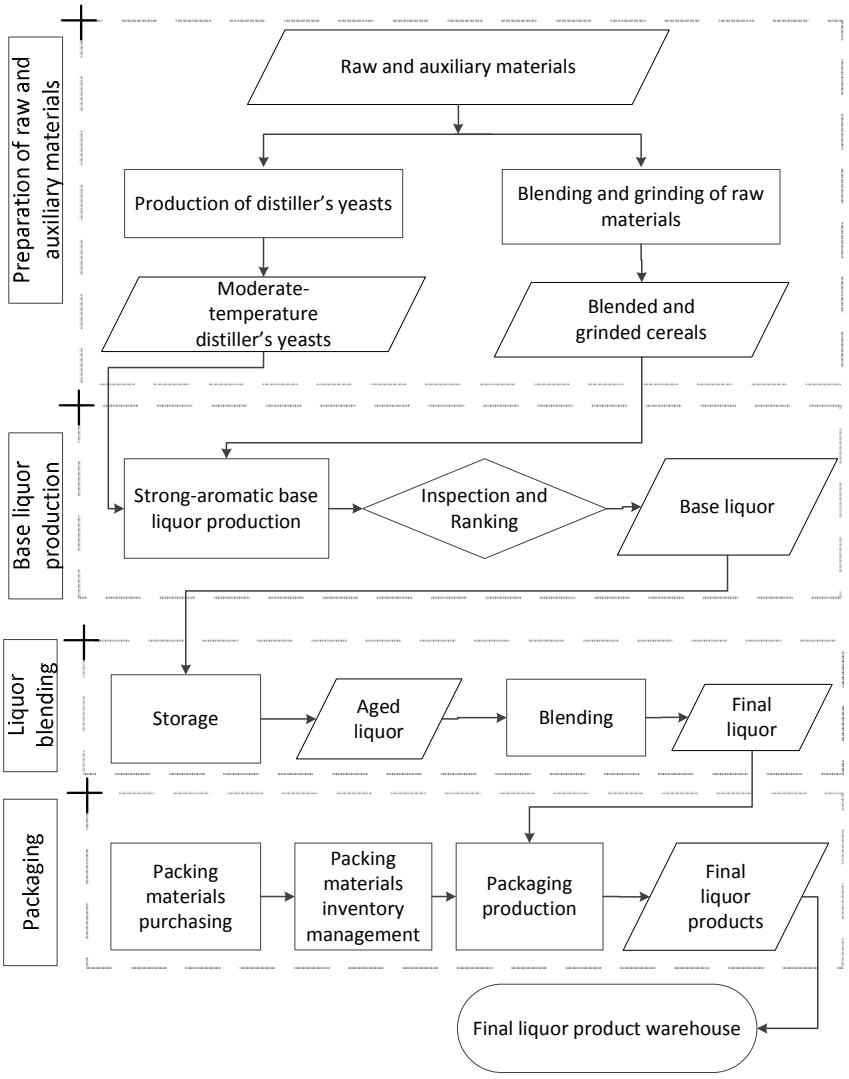

Figure 1. Simplified production flow for Chinese liquor production

(1) Preparation of raw and auxiliary materials: This process involves the production of moderate-temperature distiller's yeast and the blending and grinding of raw materials. The former consists of a variety of technical operations, such as cereal moistening and smashing, mixing of water, yeast formation, and fermentation in the yeast room. The latter mainly involves mixing and grinding of raw materials to generate mixed and grinded cereal materials. Raw materials consist of one or more different cereals, such as wheat, rice, and sorghum. The production of moderate-temperature distiller's yeast depends completely on manual operations, whereas the blending and grinding of cereals are performed by machines.

(2) Base liquor production: As the most important process in liquor production, base liquor production is done in the fermentation workshop in earth cellars, which is highly manual operation and experience dependent. A fermentation workshop usually consists of a large number of earth cellars to increase the diversity of microbial community for the fermentation process. The main technical operations in base liquor production are placing blended and grinded cereals into the cellar, sealing the cellar, taking fermented cereals out from the cellar, blending the fermented cereals with new cereals, cereal moistening, blending with cereal husks, steaming and distilling to generate base liquors, steaming and gelatinization, water proportioning, cooling, and blending with distiller's yeast.

(3) Liquor blending: This process is crucial to the quality of final liquors, which involves hierarchical storage of base liquors and their blending with additional water. The key to liquor storage is the purification and aging of base liquors in storage containers. The blending operation mainly involves combining base liquors of different grades, choosing appropriate liquor flavors, purifying the additional water, and blending aged base liquors with additional water.

(4) Packaging: The final blended liquor is packaged to produce the final product. This process involves the purchasing and inventory management of packing materials, the inventory management of final liquor products, and the packaging production of final liquor implemented by automated assembly lines.

Information system framework for collaborative and standardized Chinese liquor production

This section presents in detail the information system framework for collaborative and standardized production in Chinese liquor industry, as illustrated in Figure 2. This framework is proposed based on actual production requirements of Chinese strong aromatic liquor. Based on this framework, production collaboration and standardization are executed at two levels: operational level and decision analysis level.

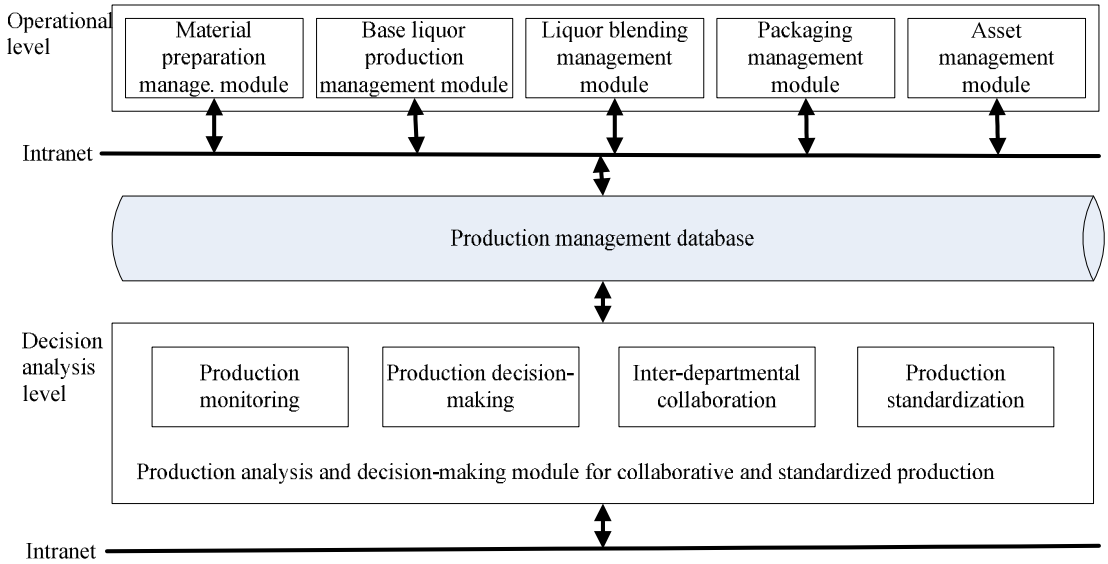

Figure 2. An information system framework for collaborative and standardized Chinese liquor production

The operational level involves the following five modules:

(1) Material preparation management module: This module is used to monitor and manage the production process of moderate-temperature distiller's yeast and the preparation process of blended and grinded cereals. Various material preparation and production-related data need to be collected. These data include the daily working records, the daily output of materials, and the real-time technical parameter settings in the material preparation and production processes, such as the temperature and humidity changes in each yeast room.

(2) Base liquor production management module: This module aims to monitor and manage technical operations in the base liquor production, such as the fermentation process in cellars, cereal blending, steaming and distilling, and cooling. Four sub-modules, namely, cellar management sub-module, cereal blending sub-module, steaming and distilling sub-module, and cooling sub-module, are used to cover these operations in this module. In the improvement or creation of the quantitative technical standards in

the base liquor production, this module functions to collect the necessary production and technical parameters of the main technical operations for analyzing and establishing the quantitative relationships between various technical parameters and liquor quality. These parameters are the temperatures in the fermentation process in the cellar and cooling process, the steam pressure in the distilling process, and the temperature and humidity of the workshop. These data collected are then used to analyze and adjust the technical standards of the base liquor production.

(3) Liquor blending management module: This module involves the whole process management and the control of production and technical processes in liquor blending production. These processes are base liquor management, aged liquor management, and liquor blending. The production and technical data involved in these processes are collected for analyzing and establishing the quantitative technical standards of liquor blending. This module is capable of implementing flexible data management and improving the timeliness and efficiency of information enquiry in the liquor blending process.

(4) Packaging management module: This module is developed to monitor and manage the related operations of the packaging-related process, such as purchasing of packing materials, packaging production of final liquor products, and effective packaging production planning and scheduling.

(5) Asset management module: Liquor production involves complicated technical operations and materials as well as physical assets located in multiple departments. Effectively managing these materials and assets by human experience and traditional manual approaches is difficult. This module is used to monitor, maintain, and manage various physical assets on a common platform. These assets are raw and auxiliary materials, spare parts, packing materials, base liquors, final liquor products, and fixed assets.

The five modules at the operation level are connected to the production management database through the Intranet. The database is also connected with the production analysis and decision-making module at the decision analysis level. On the basis of these data from the database, further production analysis and decision-making functions can be implemented at the company level for better production monitoring, decision making, collaboration, and standardization through the production analysis and the decision-making module. This module consists of the following four sub-modules:

(1) Production monitoring: This sub-module helps production management at the workshop and higher levels to track and monitor production operations and material flows in different production departments. It also provides the production management an easy way to obtain the most updated production status, such as material flow status, production progress, and outputs of each cellar or workshop.

(2) Production decision making: This sub-module provides decision-making functions at all levels of the company. These functions include material requirements and purchasing planning, production planning and scheduling, expert rating of base liquor, aged liquor and finished liquor, and optimization decision making of the blending ratios of the base and the aged liquors at different quality levels.

(3) Inter-departmental collaboration: This sub-module implements the necessary information sharing between different production departments and effective cross-departmental communication and feedback to improve the necessary information visibility and transparency. For example, information on both materials demand and production progress in the base liquor production workshop is provided to the materials department and the liquor blending department, respectively.

(4) Production standardization: This sub-module analyzes, manages, and maintains the technical standards in the distiller's yeast production, the base liquor production, and the liquor blending process. The key technical standards in the production process of distiller's yeast are yeast's inside temperatures, yeast room's temperature, and humidity. The key technical standards in the base liquor production involve three main technical operations. The technical standards in steaming and distilling mainly include steaming pressures in steaming and distilling and steaming time. The technical standards in cooling and blending with distiller's yeast are cooling time, temperature, and yeast quantity in blending. The technical standards in the fermentation cellar are the ratio of mixed grinded cereal and fermented cereals and the temperatures at different positions of the cellar in different periods of the fermentation process. The technical standards in the liquor blending production are the compositions of each finished liquor item.

Modules at the operation levels collect related data from production frontlines and save these data in the production management database. The data include the material input and semi-finished product output records of each production operation in each cellar or workshop, and the corresponding technical

parameter settings. Based on these data, the effects of the different technical parameters on the production process and liquor quality can be identified, and the quantitative relationships among material inputs, semi-finished or finished products, and parameter settings can be further established. This sub-module provides a user-friendly portal to help the related production management implement these functions to improve or create technical standards in liquor production.

System implementation — ABC Group as a case

Company overview

The ABC Group (ABC) is one of China's top high-end liquor producers. ABC Liquor is an outstanding representative of strong aromatic liquor, which is made through traditional technical operations, from fermentation in the aged cellar to years-long brewing and appropriate blending. ABC occupied 10% of the market share and 95% of the export share in the Chinese liquor industry in 2012. As a benchmarking enterprise in China, ABC attaches great importance to the implementation and application of information systems to improve operation efficiency and market competition, and is the leading Chinese liquor industry in the application of information systems. However, like other Chinese liquor producers, ABC needs to further improve the development and implementation of information systems for liquor production management.

Information systems for Chinese liquor production

ABC developed and implemented five modules based on its actual production requirements; these modules achieved the main functions under the framework described in Section 3. However, this framework also has some important modules, such as material preparation management module and some sub-modules in the base liquor production module, which have not been implemented yet and will not be included in this section. The modules implemented in ABC are described as follows:

Base liquor production management module

As mentioned in Section 3, this module consists of four sub-modules that monitor and manage four corresponding technical operations in the base liquor production. However, three of these sub-modules have not been implemented so far. The only sub-module implemented is the cellar management sub-module.

The cell management sub-module is the most important in the base liquor production management module. As shown in Figure 3, this sub-module consists of the cellar fermentation process monitoring and controlling (CFPMC) sub-module and the material input and output management (MIOM) sub-module. The CFPMC sub-module is to monitor the temperature in the cellar during the fermentation process. The hardware used in this sub-module includes temperature sensors, wireless data transmitters, wireless base stations, and a front-end communication computer. Temperature sensors are placed to detect the real-time fermentation temperature in the cellar. The temperatures detected are transmitted to the communication computer through wireless technology and then saved in the production management database. By using a user-friendly interface, the user can watch and monitor the real-time change in temperatures in each cellar and analyze the temperature change trends. The goal is to determine the relationships between the temperature changes and the fermentation process of certain material input so that the optimal temperature and technical parameters for the fermentation process can be identified. The MIOM sub-module is used to accurately monitor and collect input and output information of materials in each cellar and save this information essential to production management and cost control in the production management database.

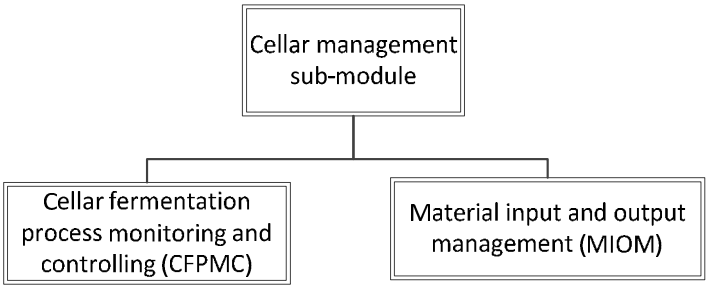

Figure 3. Cellar management sub-module

The cellar management sub-module also provides module interface to integrate with other information systems, such as ERP systems, so that the temperature change data and the material input and output data in each cellar can be used for other analyses and decision-making processes.

Liquor blending management module

As shown in Figure 4, the liquor blending management module is composed of four sub-modules, namely, base liquor management, aged liquor management, blending management, and quality management. The base liquor management and the aged liquor management aim to classify and rate the base liquor and aged liquor, respectively, by the physical and chemical ingredients, chromatography, and their inventory management. The blending management sub-module is used to manage the liquor blending operation, which records the relationship between the liquor output and its corresponding base liquor inputs to establish the fingerprint of each finished liquor item. The quality management sub-module is used to monitor and manage the quality change of liquor items in the storage process and the quality control of blending operations.

This module enables blending operators to obtain the information about quality levels, statuses, and locations of thousands of tons of base and aged liquors in the liquor warehouse. It can also accurately obtain the inventory and turnover rate of each type of liquor product. On the basis of this information and feasible blending methods, the blending operator can select appropriate base and aged liquors to blend. Moreover, the efficiency and accuracy of information inquiry as well as the information transmission speed between different departments and operators are improved greatly.

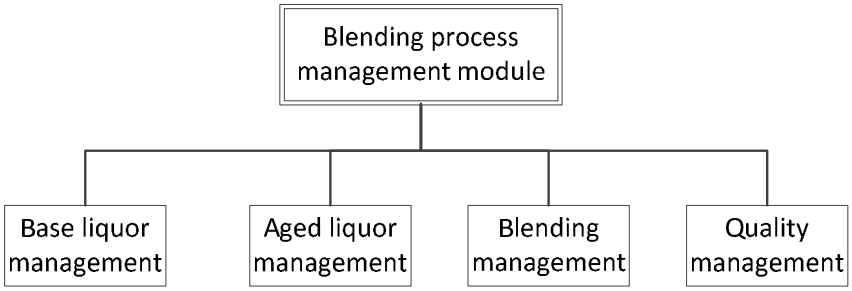

Figure 4. Liquor blending management module

Packaging management module

As shown in Figure 5, the packaging management module consists of a packing material purchasing management sub-module, a packing material inventory management sub-module, and a packaging assembly management sub-module. The packing material purchasing management sub-module is mainly used to manage packing material purchasing-related processes, such as purchasing, bidding invitation, bidding, and distribution, for optimizing purchasing process and reducing purchasing costs. The packing

material inventory management sub-module implements the inventory management of packing materials and unbottled liquors. The packaging assembly management sub-module is used to monitor and manage the packaging assembly process of final liquors and make packaging production planning and scheduling. Radio frequency identification technology is used in the packaging management module to provide the functions of counterfeiting, product tracking, and tracing.

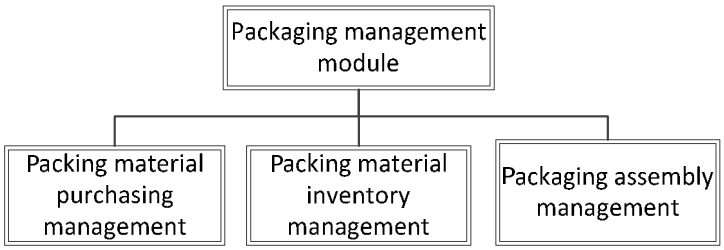

Figure 5. Packaging management module

Production analysis and decision-making module

The functions of the production decision-making sub-module have been implemented successfully in the information systems of ABC. As for other functions in the three other sub-modules, ABC already realized their importance and is improving and carrying out these functions. The company has a pressing demand to implement these functions to further improve the benefits, namely, better decision making and cross-departmental relationships brought by interdepartmental collaboration and better and more stable liquor quality brought by more effective and reliable production standardization.

Asset management module

The asset management module was developed and implemented in ABC on the basis of the actual asset management requirements in liquor production. The module is composed of a physical asset management sub-module and a unified coding sub-module, as shown in Figure 6.

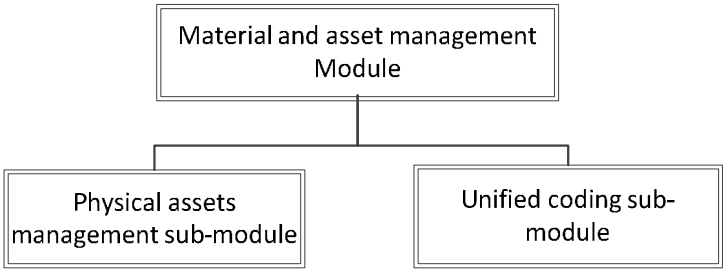

Figure 6. Asset management module

The physical asset management sub-module has two main functions: (1) to track and manage asset and location data efficiently throughout the asset lifecycle, and (2) to collect and save the details of asset-related inventory and its usage, including what, when, where, and how many. More importantly, receiving, dispatching, and storage of base liquors and final liquor products are the main functions of this sub-module. The unified coding sub-module is implemented to improve the information accuracy of various physical assets and the efficiency of physical assets by establishing a unified basic coding specification.

Without the asset management module, the reliability, completeness, and timeliness of the asset data collected are usually questionable. Therefore, learning about the statuses, locations, and amounts of

various physical assets in a timely manner may be difficult. Moreover, data cleansing and stock-taking are time consuming.

After implementing the asset management module, ABC can accurately determine the particulars of physical assets, such as what assets are owned and the current status of each item and final liquor products. The application of a unified coding specification normalizes the data of physical assets, making all assets easy to identify, track, and retrieve. The complete data visibility of physical assets is helpful in providing reliable decision supports for asset stock-taking and purchasing planning.

Discussions

Benefits of system implementation in Chinese liquor production

Aside from the general benefits reported in the literature, such as higher data completeness and accuracy, higher information visibility, shorter information sharing time, and better consistency for improved decision making, the following specific benefits were also be obtained based on the implementation case in ABC:

(1) Improvement of quality stabilization and reduction of human errors

Without an information system, the liquor quality is inevitably inconsistent because key technical operations cannot be well-quantified and standardized. After the proposed information system framework was implemented, technical operations were better standardized. Human errors were thus reduced, and the stabilization of liquor quality was improved.

(2) Better cost accounting and control

Accurately learning about the cost composition and making effective cost accounting and control can be difficult in the traditional Chinese liquor production. After the implementation of information systems, the consumptions of materials and energy in each technical operation were collected and analyzed to provide accurate data for cost management.

(3) Better cross-departmental communication and collaboration

After the implementation of information systems, the production progress and inventory information of materials, work-in-progress products, and final products were accurately collected and shared between different departments in a timely manner. Accordingly, cross-departmental communication and collaboration improve, and cross-department response become quicker.

Challenges encountered in system implementation

Based on the implementation experience in ABC, the following challenges were encountered in system implementation:

(1) Inheritance of traditional liquor-making skills

The quality of Chinese liquor largely depends on traditional skills. System application and implementation must ensure that the traditional liquor-making skills are passed down effectively and that the liquor quality does not decline. The integration of the information systems-based advanced management and operation skills with liquor production while preserving traditional liquor-making skills and improving liquor quality can be challenging. This finding is distinct, which seldom occurs in other manufacturing industries.

(2) Lack of professionals

The lack of professionals is an important risk in system implementation. As enterprises have low-level automation and informatization, Chinese liquor producers face a serious shortage of IT professionals because no information systems have been used in production frontlines. Liquor producers need to attract and train more IT professionals to participate in the system implementation in liquor production.

(3) Employee resistance

In liquor production, the kernel production processes are usually done by experienced liquor-making workers who have low education and do not like any changes. These workers are prone to distrusting information systems and resist them because they are not good at using information systems and worry that the system impairs traditional liquor-making skills. Consequently, information systems cannot be used properly, further impeding the successful implementation of systems. This finding is consistent with the study of Choi et al. (2013).

Critical success factors for implementing information systems in Chinese liquor production

We identify the following four critical success factors for the implementation of information systems in Chinese liquor production:

(1) Commitment from the management and the liquor-making workers

The support and commitment of the management and the liquor-making workers are very important in system development and implementation since system implementation in the Chinese liquor production is usually resisted. The consistent commitment from top management can deliver a clear message that the system must be implemented well and provide a more convenient access to information and resources required in implementation, thus leading to a smoother implementation process. The commitment from the relevant department management is required to effectively improve the cross-department coordination. Moreover, the system cannot be implemented without the active participation and consistent support of frontline workers because they are the end user of the system.

(2) System and vendor selection

The system must be selected on the basis of a comprehensive and objective system requirement analysis, which should be user-friendly and can meet the actual requirements of liquor production management. An appropriate vendor is very important, and the vendor should be competent enough to deliver the system with sufficient technical functionality as well as high stability and extensibility within a pre-specified time period. The vendor should know the liquor industry well and collaborate with the users closely to understand, discover, and satisfy the users' requirements so the users will accept and use the system.

(3) Team building and training

A responsible implementation team composed of IT professionals, liquor production experts, and end users must be established to collaborate fully in system analysis, design, development, implementation, and maintenance. The information system cannot be implemented successfully until the system users accept this system. Therefore, educating the relevant management and users and getting them fully involved are crucial so that they realize the importance, functionality, and benefits of information system and know how to use the system. Enhancing their acceptance of the new system and boosting their confidence in using it can be helpful.

(4) Effective incentive mechanism

Effective training only is not enough to make frontline workers use systems actively and effectively because of their inherent resistance. An effective incentive mechanism is helpful to encourage end users to accept and use the new system more effectively. The commonly used incentives are financial incentives, such as bonuses and salary increments, and non-financial incentives, such as job promotion opportunities, time off, and flexible work schedules.

These findings regarding critical success factors are consistent with the findings of previous research studies (Choi et al. 2013; Ngai et al. 2012).

Future development of information systems for Chinese liquor production

Compared with other manufacturing industries, such as automobile and steel the application and implementation of information systems in liquor production industry have a long way to go although some information systems have been implemented successfully in some liquor production enterprises in recent years. They should be enhanced from the following aspects:

(1) Development of more information systems for the base liquor production

In base liquor production, only the fermentation process in the cellar can be monitored and managed so far whereas some other important technical operations, such as cereal moistening and cooling, cannot be monitored effectively yet. Information systems are required to manage these technical operations effectively so that production data can be accurately collected, and the production standards for these operations can be quantified and standardized further.

(2) Integration of information systems for liquor production with other systems

Efforts can be made to integrate production-related information systems with non-production systems, such as office automation systems and ERP systems, to manage the operations in different departments in an integrative manner. By doing so, the information visibility of different departments can be improved, and wider and better interdepartmental communication and collaboration can be achieved.

(3) Information sharing and integration with supply chain partners

According to the supply chain integration strategies presented by Frohlich and Westbrook (2002), the information system application in liquor production is only a low integration. Related information systems need to be further developed so that the related operations in the entire supply chain can be integrated and obtain better information visibility and operation collaboration in the supply chain.

Conclusions

This paper proposes an information system framework for collaboration and standardization in Chinese liquor production. The implementation and application of information systems under this framework are presented by taking a typical Chinese liquor producer as a case. Various benefits from the system implementation are then analyzed based on the implementation experience in the case company. Various challenges for system implementation in the liquor production are then discussed. Liquor producers who desire to increase their success in implementing information systems must take the critical success factors into consideration, such as obtaining consistent commitment from the management and the frontline workers, selecting an appropriate system and vendor, building an excellent implementation team, hiring well-trained and involved team members, and using effective incentive policies.

Chinese liquor production still has room to develop and implement information systems further for, with some of the progresses having been made in recent years. An inevitable trend is to develop more information systems for monitoring key technical operations in the base liquor production, integrate the various production-related information systems with other systems in non-production departments.

Acknowledgements

The authors are grateful to three anonymous referees for their constructive comments on an earlier version of this paper. The authors would like to thank the financial supports from the National Natural Science Foundation of China (Grant No.s 71302134, 71172197) and Sichuan University (Grant No.s SKYB201301, SKZX2013-DZ07) and the second author of the article was supported in part by The Hong Kong Polytechnic University.

REFERENCES

Avison, D., and Malaurent, J. 2007. "Impact of cultural differences: A case study of ERP introduction in China," *International Journal of Information Management* (27:5), pp. 368-374.

Bansler, J.P., and Havn, E. 2010. "Pilot implementation of health information systems: Issues and challenges," *International Journal of Medical Informatics* (79:9), pp. 637-648.

Choi, T.M., Chow, P.S., and Liu, S.C. 2013. "Implementation of fashion ERP systems in China: Case study of a fashion brand, review and future challenges," *International Journal of Production Economics* (146:1), pp 70-81.

Dymoke-Bradshaw, K., and Brown, A. Year. "A Reflective Framework for Successful IS Implementation in

Healthcare: Applying Theories From IS Innovation and Implementation Research," in *Proceedings of the 5th European Conference on Information Management and Evaluation*, Como, Italy, pp. 140.

Frohlich, M., and Westbrook, R. 2002. "Demand chain management in manufacturing and services: web-based integration, drivers and performance," *Journal of Operations Management* (20:6), pp. 729-745.

Laudon, K.C., and Laudon, J. P. 2012. *Management Information Systems*, (12th ed.): Prentice Hall.

Ngai, E.W.T., Chau, D.C.K., Poon, J.K.L., Chan, A.Y.M., Chan, B.C.M., and Wu, W.W.S. 2012. "Implementing an RFID-based manufacturing process management system: Lessons learned and success factors," *Journal of Engineering and Technology Management* (29:1), pp 112-130.

Olson, D L., and Staley, J. 2012. "Case study of open-source enterprise resource planning implementation in a small business," *Enterprise Information Systems* (6:1), pp. 79-94.

Xue, Y., Liang, H., Boulton, W.R., and Snyder, C.A. 2005. "ERP implementation failures in China: Case studies with implications for ERP vendors," *International Journal of Production Economics* (97:3), pp. 279–295.

Zhang, Z., Lee, M.K.O., Huang, P., Zhang, L., and Huang, X. 2005. "A framework of ERP systems implementation success in China: An empirical study," *International Journal of Production Economics* (98:1), pp. 56-80.