NEW PRODUCT DEVELOPMENT AND INNOVATION APPROACHES: AN EXPLORATORY STUDY IN SRI LANKAN APPAREL MANUFACTURING ORGANIZATIONS

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Abstract- The New product development (NPD) and Innovation are being adopted in Sri Lankan export apparel industry to sustain in the competitive global market. This article explores the key establishments and novel approaches of NPD and innovation which are being practiced in mass-scale apparel manufacturers in Sri Lanka. Qualitative research methods were utilized in designing and analyzing the data to present the holistic view of adopting NPD and other related approaches in the practitioners' view point. This exploratory study was conducted based on in-depth interviews using semi-structured questionnaire instrument to render the practical approaches. Purposive sample of expert informants were selected from the leading apparel manufacturers with large production volumes with a diverse product categories. The phenomenological analysis method and the R open source software's RQDA package were used to analyze the interview data systematically. Subsequently, the relationships to key research constructs were extracted using codes and code categories using RQDA. In conclusion, this paper synthesizes the key approaches of NPD and innovation practised by the Sri Lankan export apparel industry drawing future directions for emerging trends in NPD and Innovation as a whole.

Key words- Apparel industry, Innovation, New Product Development, Qualitative research methods

I. INTRODUCTION

Sri Lankan apparel exports were opened to more markets with the phasing out of the Multi Fiber Arrangement (MFA) in 2005. Subsequently, that intensified the competition from other developing countries [1], [2]. More precisely, the Sri Lankan apparel manufacturers are striving for NPD strategies and innovation models to gain the competitive advantage among other export apparel manufactures. Product development is well established in the industry, to cater any request raised from any customer. NPD goes beyond that, where manufacturer strives for delivering more than customer exactly wants. In NPD, designer and product developer are looking forward to adding "*newness*" to the product by changing product attributes. That initiation would support local manufacturer to go beyond a mere contractual relationship and build strategic alliance with the customer.

Innovation addresses the unmet need of the consumer and it is one of the emerging trends in most of the apparel manufacturing firms at present. In practice, it is difficult to detached innovation from new product development. Innovation is being practiced in three directions as product, process and organizational innovation [3]. The firm can gain a competitive advantage by differentiating its output from increasing the quality and variety of goods through product innovation. Process innovations support firms to improve the quality of the products, or attain improvements in the efficiency of production. Organizational innovation strategies increase the probability of firm's success by combining product and process innovation [4]. Most of the NPD related literature has paid attention to European and American apparel retailers [5] in the marketing and management perspectives. Inevitably, there was few published literature available, regarding the NPD of apparel manufacturing in the Asian Pacific region [5]. Hence, this study is important to fill that research gap, by providing detailed analysis of NPD and innovation related to the apparel industry.

In this exploratory study, there were three research objectives defined; (1) explore the key establishments and novel approaches related to NPD and innovation in Sri Lankan apparel manufacturing context **(**2**)** Investigate key implementations of innovative computer-controlled manufacturing technologies to establish at the various stages of NPD and innovation in apparel industry **(**3**)** Infer special methodologies which are adopted to appraise critical products and discover how to mitigate the NPD risk when producing critical products in apparel context**.**

There were six research questions constructed to address these research objectives**.** They are; (1) How NPD and innovation are currently being practiced in Sri Lankan export apparel industry? (2) How to align innovative customer preferences with existing capabilities of the organization? (3) How to evaluate the progress of present NPD and innovation practices of the organization? (4) What are the motives which drive the organization for NPD and Innovation? (5) What determinants encourage the use of virtual prototyping and other CAD tools in NPD and innovation? (6) How to undertake critical products and mitigate product development risks in existing NPD and Innovation perspective? Gathering and

sharing of this systematic information on the current practices and trends in well-established organizations, would be beneficial in accelerating the NPD and innovation progress in the other organizations.

II. LITERATURE REVIEW

NPD approaches were emerging over three decades in many industries including apparel. NPD is consisted of complex processes, policies and methods and involved with many people across many functions [6]. NPD is a comprehensive process having main phases such as design, modelling/prototyping, detailed engineering, material sourcing and then ends with production and distribution [7]. Hence, NPD and innovations are more complex, changes are evident, however in slow manner. The successful firms do not depend on one NPD practice; they were succeeded by adopting number of strategies extensively [6]. Most of the NPD, especially innovation projects were driven for a longer time period depending on the project scope. NPD cycle times correlate with the newness of the project [6]. The best practiced firms in the field use multi-functional teams [8] and also cross-functional teams [9] extensively. Nevertheless, successful organizations use a structured product development process with action-oriented stage reviews and an integrated set of development tools, such as Quality Function Deployment (QFD), rapid prototyping and simulation [9]. Most successful companies pursue NPD to gain or maintain a competitive advantage and fill a growth or profit gap by utilizing novel technologies, to attract new customers ultimately [10]. During the last decades, companies had to focus more on quality of the products rather efficiency, and to quickly identify dynamic customers' needs, to develop more complex products to delight the customer [11].

III. METHODOLOGY

Qualitative research methods were used to identify the particular phenomenon to be investigated. Qualitative research methods are mostly used in educational and social research fields [12], though there can be found similar methods used in operation management [13], software engineering [14] and technology management. The qualitative research methods are important to recognize variables and define parameters in developing mathematical models and simulation systems in operations management or industrial engineering fields [15].

In this study, the face-to-face in-depth interviews were used to capture and comprehend views on current practices and future directions of NPD and innovation. Rather than using mere quantitative methods, the actual experience is better visualized in a holistic manner, when qualitative methods were incorporated in the study. Thus, the results undergo a rigorous and more informative process [14]. Further, this empirical study was conducted among leading apparel manufacturers who are responsible for producing large volumes of diverse product categories.

Purposive sampling method was used to select relevant informants for the study. The unit of analysis was 10 knowledgeable new product development practitioners who represented the unique entities of product development, NPD, Research & Development (R&D) and Innovation. The discussions focused on product engineering aspects, while describing the other key stake holder involvement. Key informants had at least 10 years of experience in the related field, and were selected based on their knowledge, role in executing such policies and practices and their flexibility to spend quality time in providing essence of the data [16]. In-depth analysis was carried out for the practical apparel product development process to identify the potential gaps.

Specified questions were developed with maintaining reliability and validity of initial research objectives and used as a standard guide for all the interviews. Each question was reviewed with the similar literature findings and preliminary understanding of the operational knowledge on the apparel industry. Hence, this interview guide was tested for the validity in the sense; whether the questionnaire measures what was intended of measuring.

For this exploratory study, informants were interviewed for one hour using same semi-structured questionnaire as research instrument and recorded using audio recorder. Subsequently, interviews were transcribed and are systematically saved and encrypted into RQDA package. RQDA software package is an open source, qualitative data analysis tool which is part of R open source statics and computing platform [17].

IV. DATA ANALYSIS & FINDINGS

The interview data was analyzed rigorously under phenomenological [18] research guidelines. Theoretical coding was used as methods of interpreting the results [19]. More precisely, there were 70 unique codes were defined in RQDA to describe the data which was extracted from detailed descriptions of the transcribed information. Subsequently, those unique codes were clustered under the defined code categories to articulate the essence of findings according to the aforementioned research questions. Figure 1 shows the internal validity of this study, in the diagram, 'RQ' indicates the **R**esearch **Q**uestions and 'C-Cat' indicates the unique **C**ode **Cat**egories.

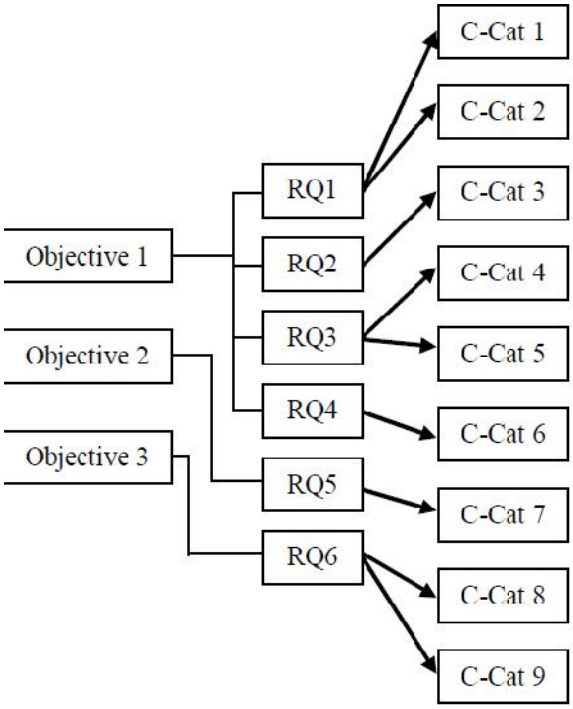

Figure 1: Qualitative data analysis guide used for the study

This clustering was used as a guide to interpret detailed descriptions of interview data. The RQDA was further used to illustrate aforementioned clusters using network diagrams. Figure 2 is an example for one of the network plots to illustrate the relationships of codes to respective code category. This example indicates the relationships of respective codes to code category number 7, which provides the guide to comprehend facts for fifth research question.

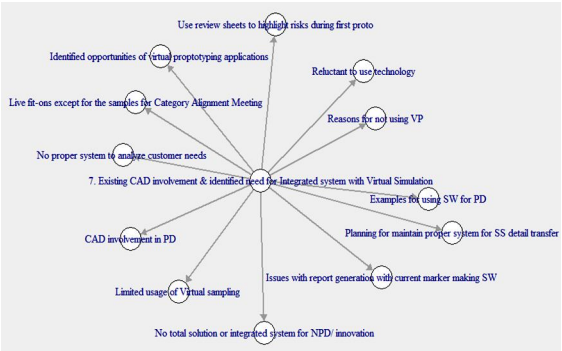

Figure 2: Network illustration using RQDA

This coding system and network illustrations were guaranteed the 'anonymity' of the each company data and also guided to formulate the findings in systematic way. Finally, the results were summarized under each research question by referring Figure 1 as a guide. The following section explains the selected Research Questions (RQs) in detail.

RQ 1 - How NPD and innovation are currently being practiced in Sri Lankan export apparel industry?

According to the interview results, Sri Lankan product developers are intriguing to initialize the product development, directly from consumer ideas. Currently they do validate their product ideas with the consumer or most probably with the customer, and initialize the NPD process. Based on the interview results, NPD approaches are classified into four categories; i.e. the new product with new technology (NPNT), new product with existing technology (NPET, here, the newness is the design), existing product with new technology (EPNT) and existing product with existing technology (EPET, here, newness is the behaviour of the application). All those approaches are applicable to Sri Lankan apparel industry and there were intriguing implications profound during the interviews. Similar model was found in the literature as *the contingency cube for NPD and R&D projects* [20].

There are several operational layers involved in the present NPD and innovation and in the context of Sri Lankan export apparel manufacturing. Over these 10 respective cases, 8 of the organizational structures can be classified into the following operational layers, i.e. *Incubation, product development, NPD, R&D, Innovation and Advanced innovation.* Basically, product development teams are responsible for garment construction, measurements and risk analysis of the styles which are confirmed for the production. In the incubation, test lot is produced to critically analyze the feasibility of the new product before transmit to the product development teams. Some firms, they repeat the incubation procedure in the factory environment also to mitigate the production risks. Innovation teams are mostly project based and average durations would be 2-3 years depending on the scope of the project. Innovation teams are not dealt with the retailers apparently, they are futuristic and they started to approach the consumer directly or via overseas research institutes. Innovation teams consist of experts in the subject and they follow various methods and tools to explore new trends and means, to address unmet need of the consumer. They use brainstorming, market research, collaborative designs projects for idea generation. In addition to that Advanced Innovation teams are engaged in 2-5 years long projects and introducing breakthrough ideas. These innovation teams inspire technologies from other manufacturing contexts and evaluate the applicability for apparel. They understand the intellectual property aspects of those technologies and define the technology readiness level (TRL) which is viable for apparel.

In between each operational layer, senior manager acts a role of a gate keeper similar to the stage gate model [21] to make sure that the new product and the product development have the proper technical transmission during each phase.

Cross functional team approach is more successful in NPD, incubation and innovation as that model will incorporate all the possible aspects into new clothing. Industry is going ahead to recruit people who are compelling with diverse skills to build cross disciplinary teams. Most of the case-organizations follow their own standard operational procedures (SOPs') in NPD. There were unique methods in reviewing new styles, allocating resources and communicating with customers. They get the support from branded systems, such as enterprise resource planning (ERP) and product life cycle management (PLM) systems to maintain databases and facilitate for internal communication. Every case-organization grants similar attention to develop both product and process innovations. Examples for common process innovations were optimizing standard minute values (SMVs) of the products, optimizing resource allocation, reducing total product development timelines etc.

RQ 2 - How to align innovative customer preferences with existing capabilities of the organization?

Each informant confirmed that, hitherto they receive majority of their orders or product ideas from the customer or brand. There are certain innovations teams are having direct access to consumers and they have their own mechanism of capturing consumer needs and analyzing them for feasible product ideas. Certain product attributes are identified and prioritized according to the consumer preferences using a ranking system. Industrialists use consumer opinion that is not to acquire breakthrough ideas from them, to validate their product offerings by direct questioning. Focus group discussions, test marketing and wearer trials evaluations to collect consumer data and then quantified to generate novel ideas. Some organizations, they have online access to precise consumer feedback on sold garments. Sometimes, Sri Lankan product developers are capable enough to identify consumer preferences and they intend to inform them to customer or in other word retailer. Some product development models are maintaining vigorous alignment between customer end and bulk production teams. The bulk production teams are engaged even in the sample production from early stages of the new product introduction. This simultaneous engineering approach facilitates to familiarization of upcoming production in advance.

RQ 3 - How to evaluate the progress of present NPD and innovation practices of the organization?

Apparently, most of the customers are not willing to accept complete designs from Sri Lankan apparel industry, since those brands are capable in that aspect. However, Sri Lankan apparel manufacturers are exploring avenues to acquire that aspect using their resonance technical capability to add value to the brand. Thereafter, some case-organizations are successful in selling technology side of the product or some parts of the products rather promoting a whole product with all the performances. Few such Sri Lankan apparel brands also had been launched with their own product innovations. Organizations monitor the success of their own NPD using a *hit rate system* and they evaluate the revenue which generate from new product introduction. On an average, most of the case-organizations maintain 30% hit rate in a season.

RQ 4 - What are the motives which drive the organization for NPD and Innovation?

Inevitably, innovation will be a necessity in next generation apparel manufacturing. Innovation would ensure the future growth of the organization while acquiring higher revenues to the organization. At the beginning, some organizations initiated NPD as a strategy of filling their additional manufacturing capacities with their own products, especially when they experience some production vacuums. At present, clear vision could be evident for promoting the innovation in Sri Lankan apparel organizations and that message had been penetrated to all the levels of employment. Company is investing on training & development, foreign exposure, partnering with foreign universities and research institutes to develop this sector. In addition to that, KPIs' are established to monitor the performance of the internal staff in terms of NPD, innovation, process developments and any other related aspects.

RQ 5 - What determinants encourage the use of virtual prototyping and other CAD tools in NPD and innovation?

Industrialists are reluctant to use virtual prototyping in apparel product development as they want to touch and feel some properties. As an example, product developers want to assess some properties such as texture, fabric weight, colour and critical construction while assessing the trial fits. In such cases, most of the product development decisions are made using live model feedback. In certain cases, product developers are finding difficulties in evaluating fit and construction with live models, mainly due to unavailable of exact models and unreliability of their fit comments. Nevertheless, virtual prototyping tools are not much popular and applied only in limited applications. According to the informants, those 3D tools need to be improved especially in developing close fitted garments such as swim wear, foundation garments, sportswear etc. Some NPD models are demanded for rapid prototyping. Current systems are having less flexibility to execute product changes. As an example, in certain rapid product development models are having only 7-8 days for product development. In such cases, CAD tools including virtual prototyping become a necessity when developing the new products within a short period of time.

RQ 6 - How to undertake critical products and mitigate product development risks in existing NPD and Innovation perspective?

Product developers follow a scientific approach in evaluating critical products. Some case-organizations have identified levels of criticality in each product category, based on the different aspects of the product development such as SMV, new machinery involvement, new fabrication and special skill requirement, using a complexity index. In order to do that, those critical products are screened to evaluate the risk factors and product developers along with the production teams pay the required attention to mitigate the manufacturing risks. In well established plants, cross functional teams have been established to handle the critical products by simplifying the methods.

Most of the case-organizations practice incubation concept and the simultaneous engineering approach, to mitigate the production risk, in the sense, production teams are also engaged in developing the products during the initial phases of NPD. Those practices would support to evaluate the optimum resource allocation, material handling, special training requirements and that will lead to minimize the learning curve, once introduced the product to manufacturing environment. Apart from all these feasibility testing, some organizations conduct pilot run in the manufacturing environment hitherto before start the production to minimize the production risks. Figure 3 summarizes the adaptation of different value stream stages of NPD with the time.

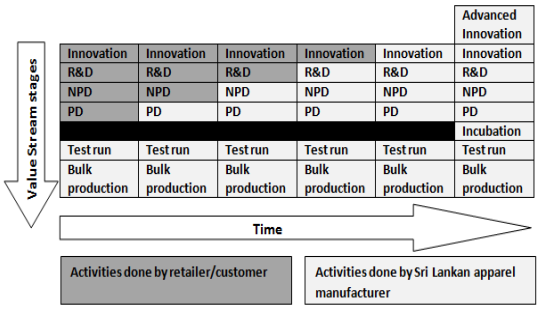

Figure 3: Emergence of different operational layers with time

CONCLUSION

Sri Lankan apparel manufacturers have been realized that there is no future in just executing existing customer needs and wants. Hence, they empower their capabilities in NPD, R&D and Innovation over the years. NPD and innovation are a necessity for the sustainability in the ever changing business world.

Most of the organizations are on the foreign consultancies to establish NPD and other process improvements for their organizations. Most of the leading apparel industrialists are actively engaged in NPD and some of them are already launched advanced innovation projects. They motivate their employees towards NPD by setting the performance measurement system to evaluate their progress. According to the PDMA best practices study by Griffin, the best firms typically have higher expectations for the NPD performance [6], [22].

Over these 10 respective studies, some similarities would be seen among mass scale export apparel manufacturing organizations. Collaborative product development models, open innovation and joint developments with the suppliers were evident and that was stipulated the platform to building strategic partnership with the customer rather having contractual relationship as earlier. Most of the case-organizations are investigating on integrated apparel product development tools which are embedded with virtual simulation. There are opportunities to improve applications of virtual prototyping, CAD involvement and visual communication in Sri Lankan apparel industry.

Always customers are eagerly searching for *newness* of the product that needs not to be groundbreaking; nevertheless they expect *newness* in any aspects in introducing the product. There is a gap of aligning innovative customer preferences with existing capabilities of the organization. Though they have been recognized the critical products in NPD, most of the organizations fail to subsidise to mitigate the risk due to absence of required operational procedures. Apparently, there is one indication that NPD is customer focused; also the innovation process was launched to approach the end consumer directly. In developing NPD or innovation model, the blend of technical and human aspects as well as product and process related aspects are identified as important. Every informant highlighted the need for integrated product development mechanism to each phases of new product introduction. Though there are separate computerized systems available to support NPD, most of them address a single function at a time.

In technical perspective, there should be a proper mechanism to analyze the new product and simplify the construction and other operational procedures to optimize the resource utilization. Integrated product development system would be more beneficial in rapid prototyping models, especially if the relevant stakeholders are based in different geographical areas.

REFERENCES

[1] M. Cammett, "*Development and the Changing Dynamics of Global Production: Global Value Chains and Local Clusters in Apparel Manufacturing*," *Competition & Change*, 2006.

[2] R. Dheerasinghe, "*Garment Industry in Sri Lanka Challenges, Prospects and Strategies*", 2003.

[3] P. Faria and F. Lima, "*Firm decision on innovation types*: *Evidence on product, process and organizational innovation*," Druid Summer Conf., pp. 1–32, 2009.

[4] W. Cohen and S. Klepper, "*Firm Size and the Nature of Innovation within Industries: The Case of Process and Product R&D*", The Review of Economics and Statistics, 78, 232- 243, 1996.

[5] W. Y. C. Shih, K. Agrafiotes, and P. Sinha, "*New product development by a textile and apparel manufacturer: a case study from Taiwan*," J. Text. Inst., vol. 105, no. 9, pp. 905–919, 2014.

[6] A. Griffin, "*PDMA Research on New Product Development Practices: Updating Trends and Benchmarking Best Practices*," Journal of Product Innovation Management, 1997.

[7] R. Bandinelli, R. Rinaldi, M. Rossi, and S. Terzi, "*New product development in the fashion industry: An empirical investigation of Italian firms*," Int. J. Eng. Bus. Manag., vol. 5, no. SPL.ISSUE, pp. 1–9, 2013.

[8] A. D. Little, "*The Arthur D. Little Survey on the Product Innovation Process*", Arthur D. Little, Cambridge, MA, 1991.

[9] C. Pittiglio, R. Rabin, P. Todd and M. McGrath. "*Product Development Leadership for Technology-Based Companies*: *Measurement and Management"*, MA, 1995.

[10] Kuczmarski & Associates, Inc. "*Winning New Product and Service Practices for the 1990's, Kuczmarski & Associates*", Chicago, IL, 1994.

[11] C. Sheperd, P. K. Ahmed, "*From product innovation to solutions innovation*: *a new paradigm for competitive advantage*", European Journal of Innovation Management, 3(2), 100-106, 2000.

[12] S. J. Taylor and R. Bagdan, "*Introduction to Qualitative Research Methods"*, New York: John Wiley & Sons, 1984.

[13] J. R. Meredith and M. Mccutcheon, "*Conducting case study research in operations management*," vol. 11, pp. 239–256, 1993.

[14] C. B. Seaman, "*Qualitative Methods in Empirical Studies of Software Engineering*," vol. 25, no. 4, pp. 557–572, 1999.

[15] B. B. Flynn, S. S. Kakibara, R. G. Schroeder, K. A. Bates, and E. J. Flynn, "*Empirical Research Methods in Operations Management*," vol. 9, no. 2, 1990.

[16] B. DiCicco-Bloom and B. F. Crabtree, "*The qualitative research interview*," Med. Educ., vol. 40, no. 4, pp. 314–321, 2006.

[17] R. Huang, RQDA: R-based Qualitative Data Analysis. R package version 0.2-1, 2010.

[18] S. Beach, "*Some Guidelines for the Phenomenological Analysis*", vol. 303, pp. 279–303, 1985.

[19] U. Flick, "*An introduction to qualitative research"*, 4th ed., Los Angeles: Sage Publications, 2009.

[20] R. Balachandra and J. H. Friar, "*Factors for success in r&d projects and new product innovation: a contextual framework*," IEEE Trans. Eng. Manag., vol. 44, no. 3, pp. 276–287, 1997.

[21] R. G. Cooper, "*What Leading Companies are Doing to Re-invent their NPD Processes*," PDMA Visions Magazine, 2008.

[22] P. Suomala, "*Multifaceted new product development performance: survey on utilization of performance measures in Finnish industry*," Perform. Meas. Manag. Control Super. Organ. Perform., pp. 1–27, 2004.

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