

Remanufacturing as a Service Embedded within Closed Loop Cloud Manufacturing System-Literature Review based Design

ABSTRACT

Aims: Current literatures inventories of both cloud manufacturing and remanufacturing are reviewed to conclude enablers to embed the remanufacturing as a service within the infrastructure of cloud manufacturing to service closed loop supply chain of sustainable manufacturing. Find out architecture of cloud manufacturing to enable embedding of remanufacturing as a service to help educational institutions conduct business seeking for human development, employment and value creation as a contribution to close the loop of supply chain for sustainable production. The study is a request to take in consideration educational institutions to be a part of global economy through remanufacturing.

Study design: Recent cloud manufacturing architectures are mixed to be modeled with take in consideration remanufacturing as a service to be conducted by educational institutions.

Methodology: Comparative literature is used to find out some statistics to show directives of literature to help embed remanufacturing within the architecture of cloud manufacturing. Thus statement of enablers can be proposed and architecture of cloud manufacturing of remanufacturing as a service can be emerged. Review of literature enables classification of macro-literature, micro-literature and barriers of remanufacturing which can be used to analog control system for assessment of literature maturity in two directions of embedding remanufacturing and educational institutions within structure of cloud manufacturing. Group of enablers for such aims are proposed to take attention of researchers for such disciplines. Controlling algorithms, structures, statics are proposed based on architectures and methodologies in fields of cloud manufacturing to embed remanufacturing in the cloud.

Results: Such sustainable approach is more suitable to be applied within societies that suffer from non-clear human development, lower education standards, without industrial infrastructure and weak communication technologies where increasing awareness of environment protection required business for value creation to be conducted. Remanufacturing will enable such societies to be linked with industrial institutions economy by establishing remanufacturing business model which is embedded as a service within the cloud manufacturing. This approach will encourage such societies to apply strict regulations to protect customer and increase value-added of imported products which end the cheap product paradigm and new markets can be included. Eco-design and eco-innovation will be crowdsourced as collaboration between university and industry. Customer integrated product development to establish product as a mixture of new and remanufactured modules according to database which is constructed through remanufacturing business and sustainable product service system. Aimed societies will be big warehouses instead of big landfills where legislation to extend producer responsibility cannot be applied. Resources of universities are integrated to process the remanufactured products and value creation will be certain sustainability based on human development, employment and ecosystem establishment.

Conclusion: Cloud manufacturing can be of closed loop supply chain globally through the embedding of remanufacturing through the platform of cloud manufacturing to be as a service . Since remanufacturing is the most sustainable procedure to flow the end-of-life phase of a product where production supply chain can be certain to be closed , so deliver remanufacturing-as-service within platform of cloud manufacturing produces a closed loop form of manufacturing to be sustainable. Educational institutions everywhere will be the intermediate bench mark and link chain to translate statistics of physical products and their quality at the end-of-life to digital form through digital library of products and their ideas of remanufacturing to be saved in the cloud. Continues review of cloud manufacturing and remanufacturing architectures can help crowdsourcing of most develop closed loop cloud manufacturing platform. Architectures and methodologies in fields of cloud computing, knowledge and expert systems can be exploited for useful remaining life evaluation, prognostics, diagnostic, shape recognition to be delivered as an integrated platform of smart sensory, collaboration between university and industry, crowdsourcing and Internet of Things to be incorporated into step by step architecting to envelop a remanufacturing as a service of cloud manufacturing sustainable model.

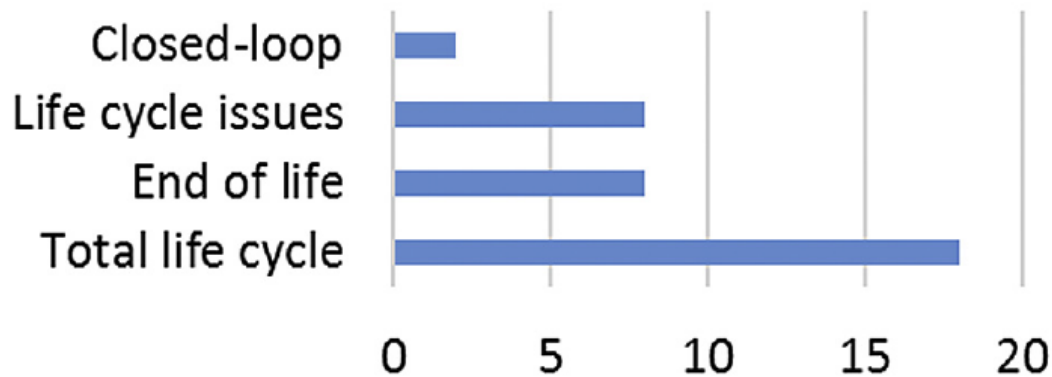
Keywords: Closed loop cloud manufacturing system , manufacturing of remanufacturing as a service, enablers of remanufacturing embedding in the cloud, educational institutions based remanufacturing, remanufacturing as a service.

1. INTRODUCTION

1.1 Literature Assessment

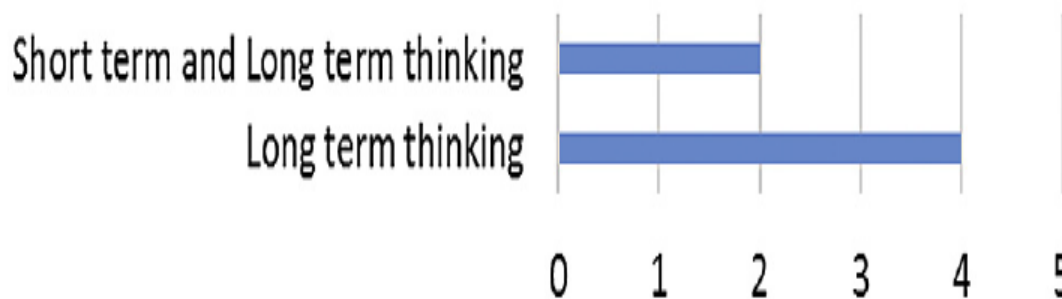
Independent cloud remanufacturing business models which based on non-mature industrial infrastructures are complex to be adopted for societies suffer from lack of infrastructures. Since the intended societies are unable of customer protection, product quality control and consequently sustainability. In this case, adoption of educational institutions based cloud close loop supply chain by remanufacturing can be interesting sustainability development approach to realize sustainable production. Sustainability of societies required sustainable production strategies for resource and environment conservation to maintain application of closed loop supply chains by remanufacturing for conservation of energy, material and value added with waste prevention and environment protection. Innovative multiple lifecycles can be predetermined at the product design stage to be applied development by remanufacturing at the end-of-life [1]. Sustainable production and remanufacturing imply meeting of the requirements for the three pillars of sustainability enhancing. Remanufacturing enhances sustainable production to certain also improved environmental friendliness, reduced cost, reduced power consumption , increased operational safety , improved personnel health and reduced wastes[2]. Sustainable production activities of optimizing use of resources through renewable energy, recycled water, inputs stemming from the recycling, recyclable outputs and recyclable wastes can certain reduction of air pollution, water pollution, land pollution, dangerous inputs, dangerous outputs and dangerous wastes [3]. Design products to be disassembled, reused, remanufactured, reduces the amount of hazardous materials using and increases biodegradable packaging which are criteria of the environmental performance level of sustainable production [4]. Total recovery cost, remanufacturing lead-time, minimization of landfill and waste and quality of remanufactured products should be optimized to reduce the negative impacts on the environment through designing sustainable products and implementing cloud manufacturing [5]. To reduce the environmental impact of products the usual reduce-reuse-recycle (3r) trilogy are insufficient to achieve the objective of sustainability, so emerging of (7r) is necessary which includes remanufacture-redesign-recover-reconfigure-reduce-reuse-recycle, such capacities can reduce the functional obsolescence of products by updating the architecture of sustainable products. Such integrating of sustainability considerations into engineering practices instead of adding additional practices and tools is a sustainable product development through eco-design

50 adoption which is an early integration of environmental aspects in development processes
51 as a sustainable decision making[6].



52
53 **Fig.1. State-of-the art of Sustainable Manufacturing[7]**

54 Closed-loop production systems and closed-loop supply chains can be achieved using
55 different approaches and strategies to contribute both of the reduction of negative
56 environmental impact and increase of economic benefits . Closed-loop production systems
57 improve sustainability and lead to improvements in economic and environmental
58 performance of an organization[7].



59
60 **Fig.2. Compression of Long term and short sustainability thinking and short term**
61 **sustainability thinking literature areas[7]**

62 Sustainable development is recognized as a long-term oriented strategy to concern both
63 current and future generations. It is thus crucial to combine short-term and long-term goals.
64 For manufacturing to be sustainable development, long-term and short-term actions are
65 required. But even long-term perspective is essential for manufacturing organizations to
66 achieve sustainable development. However, analysis can show that the time perspective is
67 taken rarely with emphasize on short-term thinking for sustainability but the need to focus on
68 both long and short-term aspects is highly required [7].
69 Application of logical paths to find out economic concurrent engineering for end-of-life
70 actions which facilitates reclamation of raw material is a trans-boundary closed loop supply
71 chain to cut of power and carbon emissions of two open supply chains one for manufacturer
72 and another for remanufacturer(recent consumer) as a sustainable manufacturing
73 application. It is an incorporation of both of long term and short term thinking of sustainability
74 ,figure 2,through eco-design based remanufacturing [8]. This is highlighted through the work
75 of [7] which concludes "However, we found only eight articles in this review to include end-
76 of-life issues such as recycling, reuse, remanufacturing, etc. Also, only two articles use a

77 *closed-loop aspect in connection with the definitions; closed loop product life cycle (Lee et*
 78 *al., 2014) and closed loop supply chain (Abullah et al., 2015)."* [8]. Thus remanufacturing is
 79 the required activity to close the supply chain and predominate sustainable manufacturing.

80 According to figure 3 , remanufacturing literature can be classified into Micro-Literature to
 81 include:-

- 82 1- Educational Institutions Internet of things
- 83 2- Educational Institutions based Data Acquisition Application.
- 84 3- Cloud Storage and Cloud manufacturing Platform.
- 85 4- Design for Remanufacturing.
- 86 5- Product Service System.

87

88 And Macro-Literature which includes:

- 89 1- Cloud Manufacturing of Remanufacturing as a Service Enablers.
- 90 2- Feasibility of Remanufacturing.
- 91 3- Barriers Analysis.
- 92 4- Technology Selection.

93 What is called Micro-Literature is a term used within this paper to show that low attention
 94 literature due to non-taken inconsideration through the published literature paper. Such
 95 literature is the most important to help close supply chain by a non-industrial country. The
 96 most highlighted literature is called Macro-Literature which most suitable to be applied by an
 97 industrial country. So figure 3 is an assessment of the micro-literature of remanufacturing
 98 contribution to help emerging of cloud manufacturing of remanufacturing as a service as a
 99 sustainable cloud manufacturing paradigm.

100 **1.2 Remanufacturing Disciplines Proposing**

101 Disciplines based assessment of the micro-literature of remanufacturing contribution to help
 102 emerging of cloud manufacturing of remanufacturing as a service through integration of
 103 educational institutions with industrial institutions to close the supply chain by
 104 remanufacturing as an end-of-life treatment which leads to sustainable manufacturing. Such
 105 assessment is necessary to feedback remanufacturing literature about its contribution in
 106 theorizing the required enablers to embed remanufacturing within cloud manufacturing,
 107 especially macro-literature to strengthen remanufacturing at feasibility study. It is found that
 108 such literature includes: Sustainability , Reusing , Deteriorating , Hybrid closed supply chain ,
 109 Remanufacturing Supply chain design , Reverse Logistic , Planning , Decision Problems ,
 110 Management , Timing , Cost and Price , Inventory and planning problems , and polices and
 111 customers.

112 Micro-literature of remanufacturing can be proposed to include:

- 113 • Cloud manufacturing of remanufacturing as service enablers.

- 114 • Educational Institutions Product Service System.
- 115 • Educational Institutions Cloud remanufacturing.
- 116 • Educational Institutions Internet of Things.
- 117 • Educational institutions based data acquisition systems application.
- 118 • Eco-design for remanufacturing.

119 Review of the state-of-the art of remanufacturing leads to find some leak point of It can not
 120 to be find within the micro-literature of remanufacturing, which is required for sustainable
 121 manufacturing , what is proposed to be micro-literature in this paper and instead literature of
 122 remanufacturing includes the nearest directive to include:-

- 123 • Cloud remanufacturing.
- 124 • Radio Frequency Identification (RFID).
- 125 • Internet of Things for remanufacturing.

126
 127 To conclude the assessment process, feedback of current directives of remanufacturing
 128 literature can name barriers of remanufacturing. Especially barriers resources of
 129 remanufacturing can include further to what are named in [9]:

- 130 • Relationship with core supplier.
- 131 • Remanufactured product selling.
- 132 • Knowledge and abilities of employees.
- 133 • Design for remanufacturing.
- 134 • Information flow on remanufacturing system.
- 135 • Legislation.
- 136 • Micro-literature research driving motivations

137

138 **1.3 Literature Statement**

139 Sustainable development to meet the needs of the present with keeping the ability of future
 140 needs through sustainable production of closed supply chain through closed product
 141 lifecycle can be by remanufacturing. Current production supply chain should be changed by
 142 sustainable production closed supply chain through introduction of educational institutions to
 143 be a part of global economic and close the supply chain by remanufacturing through cloud
 144 manufacturing of remanufacturing as a service. It can easily show , there is very low
 145 percentage of remanufacturing literature, which is macro-literature, is detected to
 146 sustainability that include enablers of remanufacturing as a service within cloud
 147 manufacturing platform. The first step for educational institutions is the conducting of closed-
 148 loop remanufacturing, figure4, to interest research for enablers maturity.

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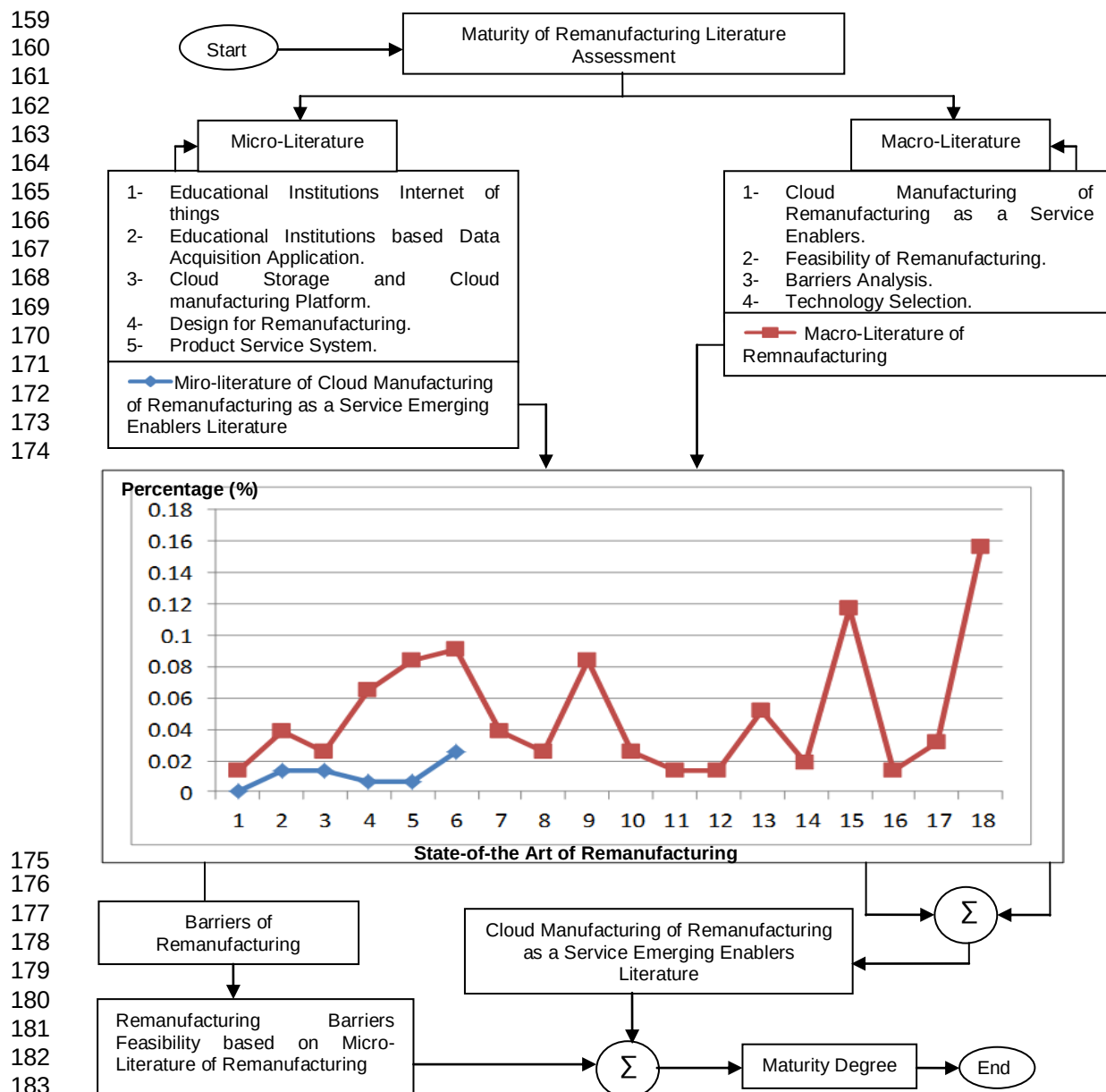
150 **1.4 Findings of State of-the Art of Sustainability, Sustainable Manufacturing and** 151 **Remanufacturing Reviews are:**

- 152 • Closed supply chain of production by remanufacturing is sustainable production.
- 153 • Sustainable production is triple line sustainability and development approach.
- 154 • Cloud manufacturing platform with remanufacturing-as-service is closed loop supply
 155 chain manufacturing which combines long term and short term suitability thinking .

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Fig. 3. Assessment of the micro-literature of remanufacturing contribution to help emerging of cloud manufacturing of remanufacturing as a service

1.5 PROCEDURE TO STOP UNSUSTAINABLE CONSUMPTION:

- 188 • Eco-design and multiple lifecycle of products.
189 • Raising the value of end-of-life product by remanufacturing.

190 Thus pro-environmental using and sustainable consumption can be emerged to help conduct
191 of remanufacturing which is necessary for sustainable production of closed loop supply
192 chain. Final incentives can induce cooperative social forces to be optimized as voluntary
193 efforts according to maturity of society in accordance to environmental awareness and
194 protection. The key factor is how to realize the social contract to be the revival to pull the
195 development of the sustainable production as a social responsibility so the sustainability can
196 be improved when environmental innovation is applied [9,10] , such as eco-design.

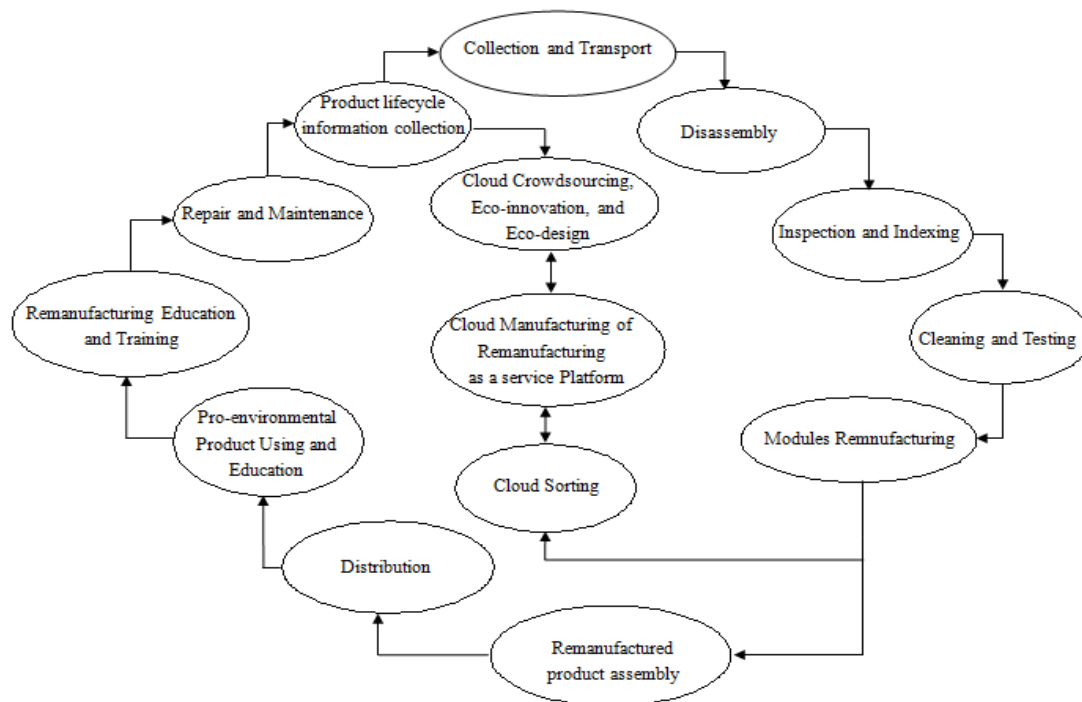


Fig.4. Proposed closed-loop remanufacturing

2. LITERATURE REVIEW

2.1 Drawbacks of Recent development of Cloud Integrated Remanufacturing

- Cloud computing cannot deliver transition from cloud manufacturing to cloud remanufacturing without mature manufacturing infrastructures to include remanufacturing as a service.
- Independent cloud remanufacturing is architected [9, 10] which is not suitable to be applied in educational institutions without manufacturing infrastructures and Internet of Things bases.
- Educational institutions have no manufacturing infrastructure so special remanufacturing industry sector is not proper choice.
- Remanufacturing with Radio Frequency Identification, as example, enables optimization, waste reduction and quality improvement application [11].
- Even Internet of Things supports quality management and product recovery optimization [12], but requirement and infrastructure of bifurcations cannot be realized.
- Infrastructures of manufacturing , Internet of Things and customer protection are not well prepared to discover any hidden lowering of product value added to prompt cheap production paradigm which drives towards unsustainable behavior .
- By considering, figure 5, to conclude the suffering from non-extending of manufacturer responsibility to process end-of-life products. Also obviously , conclusion can state that a famous brand products with unknown manufacturer even Radio Frequency

Identification tags are included since the legislations can only be applied in Europe while the product sold in different markets where no Internet of Things facilities.

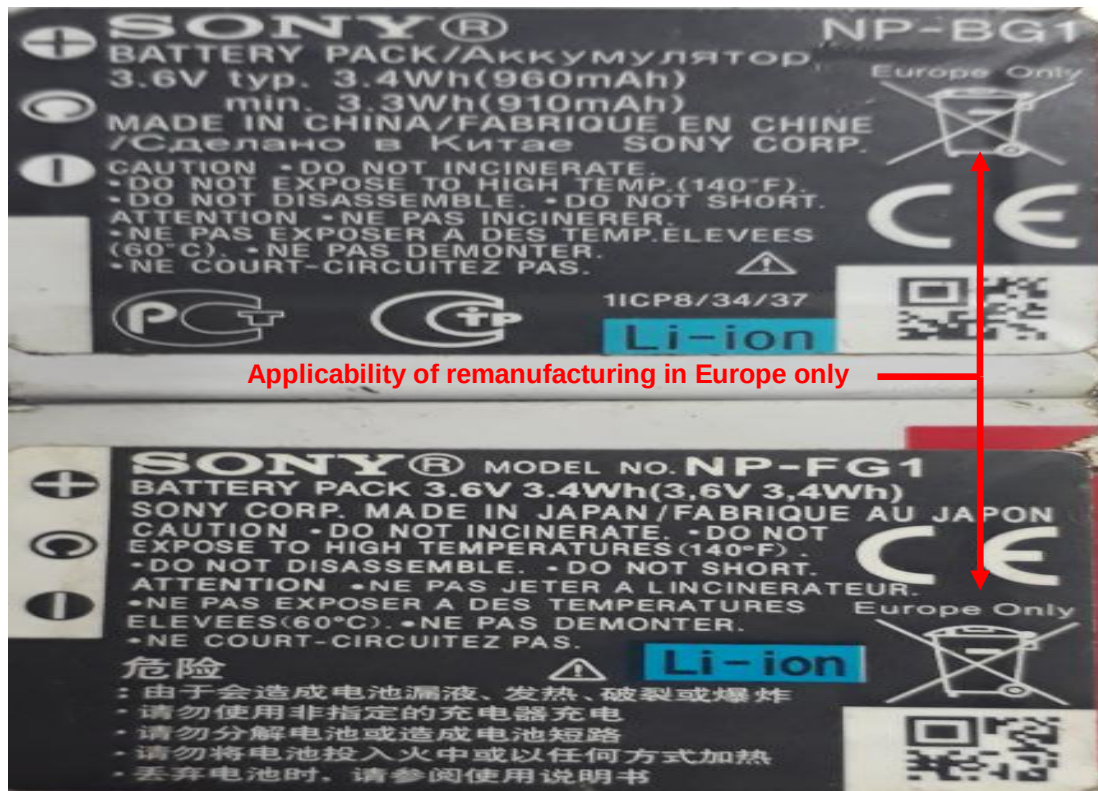


Fig.5. Illustration of Non-applicability of Radio Frequency Identification since Remanufacturing Limited to Europe Only

2.2 Solution Package

Since Internet of Things is not well done in educational institutions so:-

- Educational institutions Internet of Things enables cloud library as big information storage of end-of-life products.
- University and Industry collaboration can be employed to focus attention of crowdsourcing to evaluate end-of-life products status and to suggest appropriate remanufacturing treatment.
- Digital ware house in the cloud can be established to certain stream of well-informed end-of-life products, imaging and CAD files can be accompanied material properties, and to link resources of industrial and educational institutions .
- Eco-design and eco-innovation can be induced crowdsourcingly to match remanufactured modules to function with new product architecture.
- Data base, knowledge base and expert base can also crowdsourcingly developed into information to strength data acquisition base.

- Adaptive machine learning can be achieved through crowdsourcing training and testing applications.

Accumulation of expert and knowledge are urgently needed due to huge lack in design and manufacturing conscious environment bases of educational institutions.

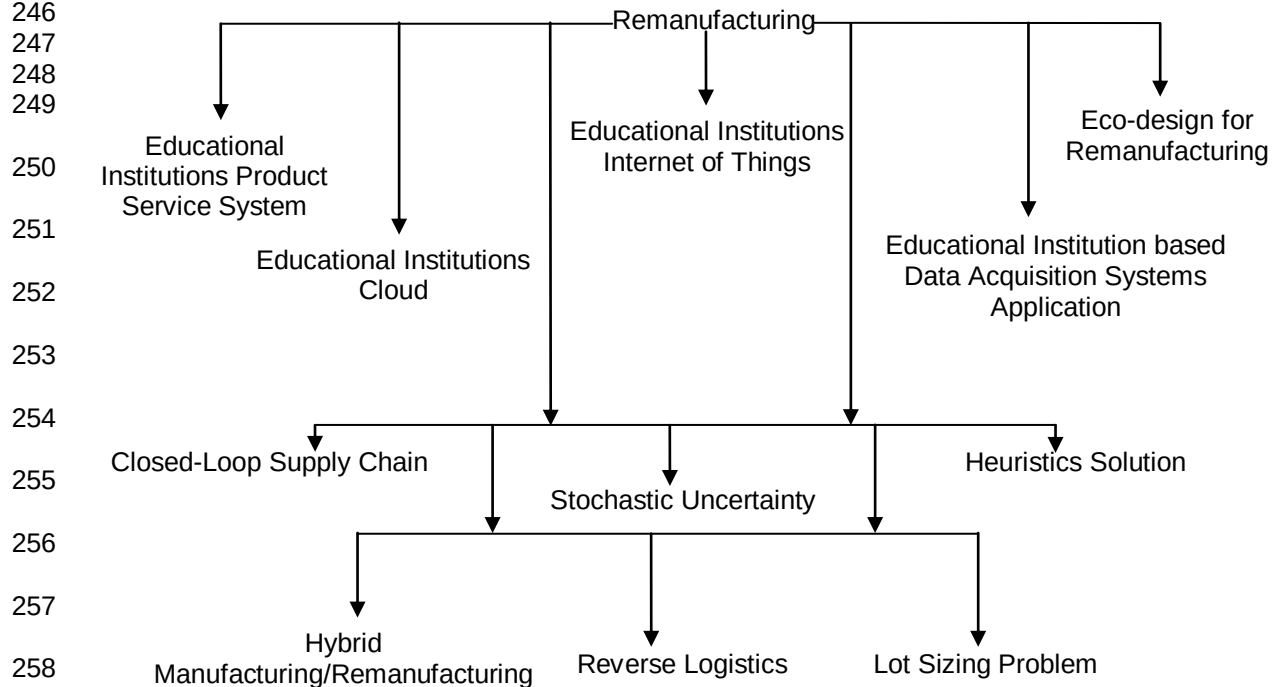


Fig. 6. Proposal of Priority Structure of State-of-the Art of Remanufacturing to Help Emerging of Remanufacturer Educational institutions

3. MOTIVATIONS OF CLOUD MANUFACTURING OF REMANUFACTURING AS A SERVICE SYSTEM

- Quality management and optimization by Internet of things application: Eliminating uncertainty due to variation of types, conditions and remaining lives of components of end-of-life products can facilitate planning of remanufacturing operations. [11].
- Hybrid manufactured and remanufacturing modules to produce new products: New products are manufactured base on hybridity of remanufacturing of modules from old returned items and new manufactured modules [12].
- X- Grade as a service: Physical products with associated services bring more value to final customers than the pure physical objects only without accessories and services. Cloud manufacturing systems result higher individualized and user-friendly product based on experiences acquisition and reflect intelligent and connected products throughout whole life-cycles. Product service systems merit flexibility, adaptability, reactivity, expertise, and X-gradability. Such X-gradability approach enables sustainable products and satisfaction for users' expectations by delighting with intensive engagement in product design, functionalities, services, and individual experiences.

278 Production of personalized products can be facilitated through integration and
279 collaboration of virtual social network, internet of things, cloud manufacturing and
280 product service system. [13].

281 • Mass customization and personalization: Manufacturing and product services systems
282 design, plan and operate globalized manufacturing networks that can encounter
283 decreasing lifecycles, increased product complexity, mass customization and demand
284 volatility. Cloud automated closed loop control systems are necessary to deliver
285 technology and related businesses approaches globally and enable optimizing of
286 enterprise performance in area of design and planning of manufacturing networks for
287 mass customization and personalization. Through supporting and promoting of dynamic
288 configuration and optimal routing of manufacturing networks and facilities, time,
289 complexity environmental constraints, and product service personalization [14].

290 **4. CLOUD MANUFACTURING OF REMANUFACTURING AS A SERVICE** 291 **EMERGING ENABLES**

292 To realize sustainable manufacturing based cloud manufacturing, priority of structure of
293 state-of-the art of remanufacturing are proposed to help emerging of remanufacturer
294 educational institutions , Fig. 6, which include :-

295 **1. Educational Institutions Internet of Things**

296 Virtualization and cloud computing can fulfill integration of sustainable manufacturing
297 infrastructures to be accessible anywhere and anytime through Internet of Things which
298 extends the cloud computing concept beyond computing and communication to include
299 everything especially the physical devices [15]. Networked smart objects with
300 communication, sensory and action capabilities can achieve global supply chain
301 management [16]. Tangible benefits to the society, environment, economy and individual
302 citizens can be certain as sustainability delivering through infrastructure of ubiquitous
303 computing technologies and applications with various forms of sensing devices based on
304 digital and radio frequency identification enablers[17].Information and communications
305 technology based businesses are strong innovation networks under the management and
306 interventionist of government to enable the successful technology catch-up and providing
307 various financing policies and programs to develop high technology based businesses as a
308 strategic implementation of innovation financing programs provide useful lessons for
309 educational institutions [18].So interventionist of government development can be directed
310 as educational institutions Internet of Things, figure 7.

311 **2. Educational institution sustainable product service business-education-training** 312 **model**

313 Radio Frequency Identification application in the field of remanufacturing is taken very
314 limited literately, and also for limited application of this technology in the aimed educational
315 institutions in this study. So data acquisition of product lifecycle and particularly end-of-life
316 products should be done through institutional platform under the supervision of specialists.
317 Deliver of data about product lifecycle cannot be certain without experience which is hard to
318 be gotten by individuals. Internet of Things has advanced to a new level with RFID to deliver
319 intelligent sensory to be interconnections between physical devices and products which can
320 be developed to include product lifecycle to provide enough information about end-of-life
321 quality and how to remanufacture the modules and consequently application of eco-design
322 to include the module within the architecture of new products[19]. But this required robust
323 infrastructure which is not available for the aimed educational institutions in this study, so
324 emerging of educational institution sustainable product service business-education-training

325 model, figure 8, can be a promising employment of technology to support remanufacturing
326 embedding in the cloud as a service.

327 **3. Cloud storage and cloud manufacturing platform**

328 Product lifecycle related data are stored at designated servers, and users know where these
329 data and which manufacturing cloud platform providing them. Networked enterprise data are
330 stored in virtualized data centers and data can span across multiple servers. The data can
331 be accessed through a web service application programming interface or a web browser.
332 Cloud based data storage provides users with ubiquitous access to a broad range of data
333 stored in the networked servers through a web service interface. Thus data storage can
334 easily scale up and down as needed on a self-service basis.

335 **4. Eco-design**

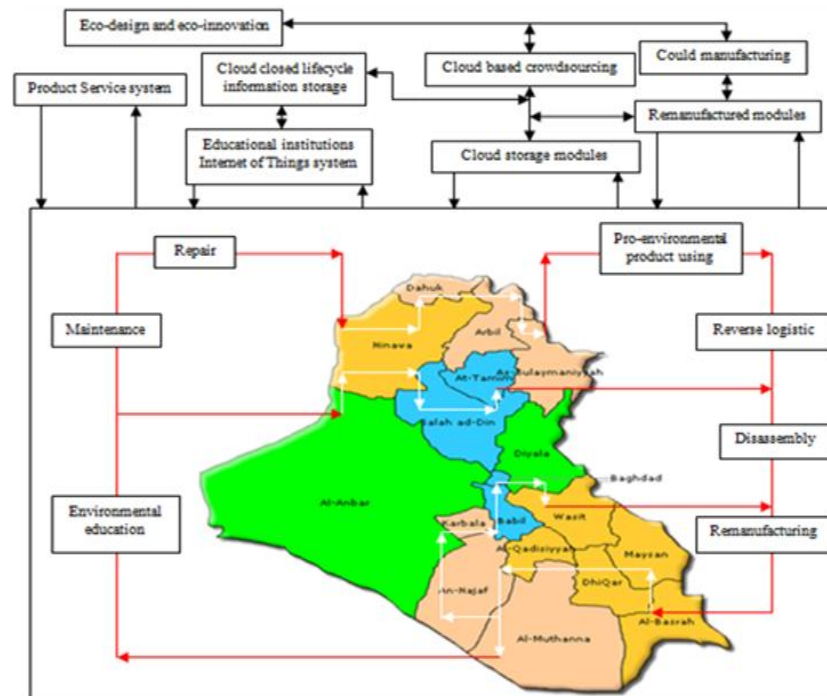
336 Cloud manufacturing provide distributed resources encapsulation as cloud services ranging
337 from product design, manufacturing, remanufacturing testing, management and assessing of
338 all information of product lifecycle. Cloud manufacturing service platform performs search,
339 intelligent mapping, recommendation and execution of a service, and thus eco-design as a
340 service can be delivered. Equipment, computers, servers, raw materials, simulation
341 software, analysis tools, know-hows, data, standards, employees, product design capability,
342 simulation capability, experimentation, production capability, management capability, and
343 maintenance capability can be exploited to remanufacture end-of-life modules and embed
344 them within new products structure. Such all as a service, in the cloud, can easily provide
345 eco-design which is the best method to include the taken back from landfills end-of-life to be
346 remanufactured and used [19]. Requirements elicitation is prepared through product service
347 systems to incorporate customers' expectations and end-of-life modules to be ready to use
348 for design purposes. Cloud based information management tools allow for enhancing
349 information flow management practices that can significantly improve design productivity.
350 Such collaborative design is information driven process among design activities. Data mining
351 and visualization technologies have the potential to significantly increase the productivity of
352 design process by allowing searching of design data for the right design information from the
353 right resources. Data consistency, transparent communication and seamless information
354 sharing are aimed activities which are more cost effectively and efficiently by using cloud
355 based design.

356 **5. Sustainable Product Service system**

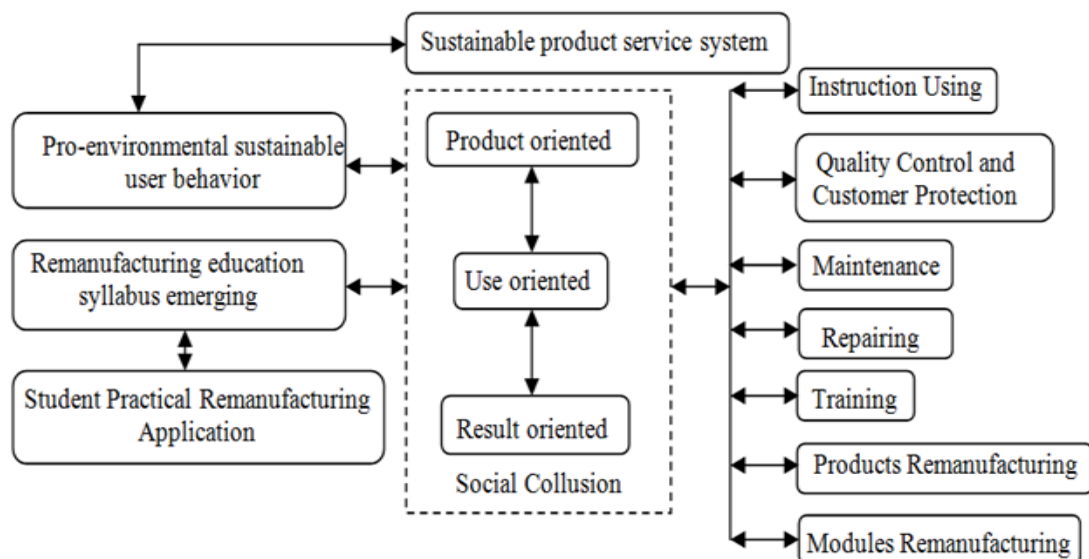
357 Customer value proposition is priority through software enabled services and business
358 oriented customer value creation. Industrial software and product service system for
359 products, services and solution of a problem and fulfillment of needs are hybrid value
360 creation, which characterize the overall value proposition level by customization and
361 strategic integration, organizational, marketing, design, innovation, and business levels,
362 sustainability aspects and the macroeconomic perspective delivery . As a consequence,
363 fruitful collaboration processes, value creation networks, knowledge sharing and
364 management, and business models.

- 365 • Institutes of technologies based national maintenance, repair and remanufacturing
366 based sustainable product service system.
- 367 • Local independent remanufacturers' acquisition.
- 368 • Reverses logistics strengthening, bifurcating and enlarging.

- 369 • Eco-design, eco-innovation and design for remanufacturing are legislated to certain
370 remanufacturability of new imported products.
- 371 • Gradual complex products remanufacturing.
- 372 • Local cloud end-of-life modules library and information system.



373 **Figure 7 Illustration of proposed educational institutions based Internet of Things**
374 **model, map is taken from(www.longwarjournal.org)**
375



376 **Fig. 8. Illustration of educational institution sustainable product service business-**
377 **education-training model**
378

379 **5. REQUIREMENTS OF CLOUD MANUFACTURING OF REMANUFACTURING**
 380 **AS A SERVICE [13]**

381 1-Social media can base delivering of services that support communication, information and
 382 knowledge sharing and emerge individual service providers to enable users-customer
 383 interaction with the global community of experts and educational institution Internet of Things
 384 to exploit, utilize and leverage crowdsourcing processes in design and manufacturing.

385 2-Elastic cloud-based distribution and storage systems to allow ubiquitous access to design
 386 and manufacturing data, which also allow collaboration and enable automatic sharing,
 387 maintain, and synchronize of data files and instant exchange.

388 3-Multi-tenancy environment, web browser enables single software serves multiple tenants
 389 and provides instance software as a service application, as a cloudification of software aided
 390 manufacturing.

391 4-Educational institutions and integrated product service system can manage Internet of
 392 Things for collection of end-of-life and whole lifecycle information to be stored in the cloud
 393 based distribution and storage file systems, with cloudification, collected and stored real time
 394 data of workflow, availability and capacity from manufacturing resources. To allow remote
 395 monitoring and controlling planning, scheduling, and dispatching incorporated
 396 remanufacturing. Internet of things infrastructure leak substitution is necessary through
 397 educational institutions integrated internet of things.

398 5-Service oriented manufacturing should be adopted to provide everything as a service as
 399 an X-as-a-service within suits of infrastructure as a service, platform as a service and
 400 software-as-a-service

401 6-Intelligent search and quoting engines enable online suitable allocation of manufacturing
 402 resources in the cloud and quoting based on design and manufacturing specifications.

403 **6. PROPOSED CLOSED LOOP CLOUD MANUFACTURING OF**
 404 **REMANUFACTURING AS A SERVICE**

405 Proposed closed loop supply chain of cloud manufacturing, figure 9, through integration of
 406 remanufacturing as a service enablers Strategic business models of remanufacturing based
 407 sustainability of educational institutions should be emerged. So some primarily preparations
 408 are required such as private recycling reverse logistic of Aluminium and Plastics are
 409 integrated within national reverse supply chain by financial incentives. Public media
 410 promotion can strength this chain by satisfaction of public discussion to induce sustainable
 411 development. Education disciplines are emerged to include remanufacturing and provided
 412 practical syllabus to be achieved by student to satisfy graduation requirements. Cost/labour
 413 ratio is as low as possible due to exploit educational and social activities to substitute the
 414 labour intensive remanufacturing by green power man. Digital library can contain detailed
 415 information such as CAD files, pricing, quantity, quality, mechanical and material properties
 416 and product status. Exposure of such information to crowdsourcing and adaptive learning
 417 knowledge and expert systems internationally results into mature information about how to
 418 remanufacture these modules. A digital bank of eco-ideas can satisfy exploiting of this
 419 mature information for sustainable integration of remanufactured modules within eco-
 420 products structures through cloud manufacturing systems, figure10.



Fig.10. Elements reaction through proposed closed loop cloud manufacturing platform to deliver remanufacturing as a service, based on [12]

427 7. RESULTS DISCUSSION AND CONCLUSION

428 Two directives of literature can be extracted, one is the viability of remanufacturing, which
 429 freezes remanufacturing in the stage of feasibility, and the second is the exploiting of
 430 information and communication technology to close the supply chain of manufacturing
 431 through cloud of everything as a service. Also an appreciated attempted to help emerge
 432 cloud remanufacturing is offered by [20]. All of these directives did not take inconsideration
 433 educational institutions, especially without industrial infrastructure, because there are no
 434 feedbacks from such institutions. The breaking of current manufacturing supply chain should
 435 start in literature to be followed by integration of educational institutions within global supply
 436 chain. Researchers should take in consideration that employments and human development
 437 are necessary needed incentives to integrate more than two thirds of man powers which live
 438 as consumers and change their areas into big landfills. These force us to propose:-

439 1- Remanufacturing as a service can extend cloud manufacturing to include educational
 440 institutions .

441 2- Current global economy should be extended to include educational institutions .

442 3- Remanufacturing is more suitable business to cope with earth resources depletion, since
 443 it satisfies ambitions of educational institutions and industrial institutions to close the
 444 supply chain.

445 4- Most remanufacturing barriers and feasibility literature can be mitigation through
 446 integration of educational institutions within global economy.

447 5- Literature directive should be changed to generate enablers to extend not just the
 448 manufacturers responsibility but also acquire educational institutions the required
 449 remanufacturing technology.

450 6- Product service systems and Internet of Things are more suitable to be institutions of
 451 educational institutions under educational supervision.

452 7- Satisfaction of enablers as mentioned can deliver sustainable manufacturing.

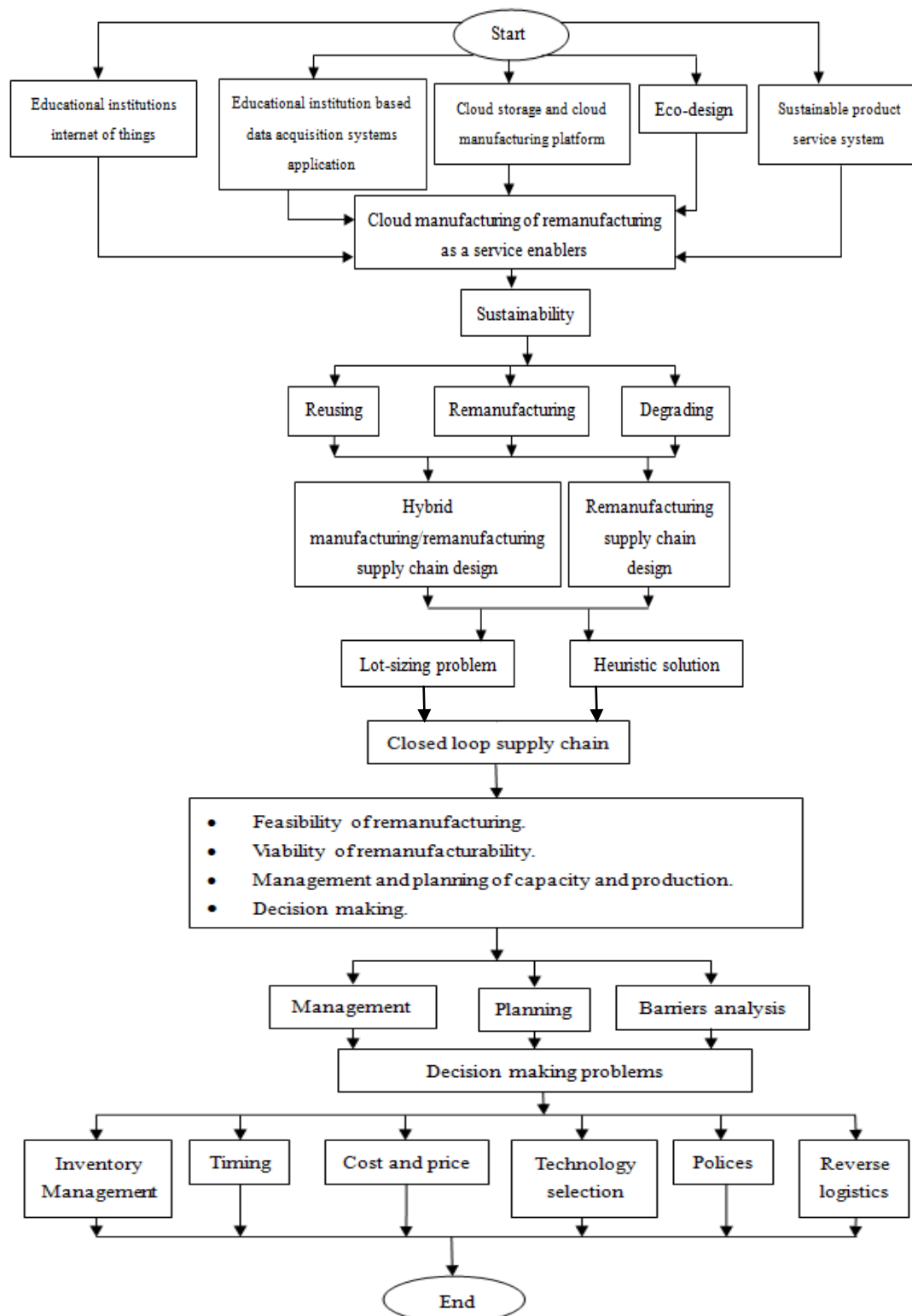
453 Powerful exploiting of man power can be through integration of scientific research and
 454 remanufacturing literature through integrated platform of product life cycle assessment by
 455 educational institution internet of things and cloud storage to mature the collected data
 456 .Fig.10 shows an integration of remanufacturing literature as a tool to help educational
 457 institution internet of Things to be embedded within architecture of Cloud Manufacturing for
 458 data maturing. Thus a scientific research based crowdsourcing can be maintained to be
 459 applied for industrial information realizing to be more satisfied to emerge integration of
 460 remanufactured modules within new products. Fig. 11 explains how the relation should be to
 461 induce positive reaction among elements through cloud manufacturing platform to deliver
 462 remanufacturing as a service. The role of educational institution can be focused in the
 463 following points:-

464 • Strengthen the relation among stockholders.

465 • Apply life cycle assessment.

466 • Mature end-of-life data to be applied for remanufacturing.

Fig.11. Proposed Integration of remanufacturing literature as a tool to help educational institution internet of Things to be embedded within architecture of closed loop cloud manufacturing system for data maturing, based on [13], [19]



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490 **Fig. 12.** Proposed remanufacturing literature directives priority to help emerging of
491 remanufacturer educational institutions to close the loop of cloud manufacturing by
492 remanufacturing as sustainable manufacturing

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